ENGINEERING NEWS

A JOURNAL OF CIVIL, MECHANICAL, MINING AND ELECTRICAL ENGINEERING

Vol. 62. No. 1. 220 Broadway, New York, July 1, 1909.

TABLE OF CONTENTS.

	Page.
LEADING ARTICLES:	
Engineering Features of the Alaska-Yukon-Pacific Exhibition (illustrated)....	1
Some Simple Causes of Mine Explosions (illustrated); L. D. Tracy, Assoc. M. Am. Soc. C. E....	2
Failures of Engineering Works; Causes and Remedies; Charles B. Dudley....	4
An Attempt to Destroy Canal Lock-Gates by Dynamite....	5
A Reinforced-Concrete Viaduct with Some Structural Steel Reinforcement, Takoma Park, Md. (illustrated)....	6
First Convention of the American Institute of Chemical Engineers....	7
Difficult Bridge Work in Great Britain (illustrated)....	8
Underpinning a Leaning Chimney with Concrete Caissons (illustrated); Ogden Merrill, Assoc. M. Am. Soc. C. E....	11
Annual Meeting of the Master Car Builders' Association....	12
Tests of a Double-Zone Bituminous Gas Producer (illustrated); John B. Klumpp, C. A. Graves and I. E. Moultrop....	13
Fuel Economies on the Locomotive....	15
Detroit River Tunnel Electric Locomotives (illustrated)....	16
Time Tests of Preservative Coatings on Steel Cars....	20
Annual Meeting of the Society for the Promotion of Engineering Education....	21
Crushing Tests on Water-Soaked Timbers (illustrated); Edward C. Sherman, Assoc. M. Am. Soc. C. E....	22
The History of Units of Land Measurement in England; Wilfrid Airy, M. Inst. C. E....	23
The Construction of a Concrete Mass and Blockwork Quay Wall by Helmet Divers in Open Water (illustrated); John Taylor, Assoc. M. Can. Soc. C. E.	24
Present Tendencies of Technical Education; F. E. Turneaure....	25
EDITORIAL....	17
Open Caissons for Deep Foundations—The Incorporation of the Baldwin Locomotive Co.—Combination of Municipal Laboratories at Brockton, Mass.	
The Freight-Car Surplus and Car Efficiency....	17
A Shady Side of British Municipal Government....	18
LETTERS TO THE EDITOR....	18
Standard Methods of Bacterial Water Analysis; Philip Burgess—A Primitive Bridge with Cantilever-and-Suspension Combination (illustrated); W. D. Holt—Rates of Pay for Subordinate Engineering Assistants; A. L. Dabney—Expansion Allowance at Rail Joints; A. Q. Campbell—Actual and Estimated Weights of the Blackwell's Island Bridge Superstructure; "Engineer"—Typhoid Fever in Some of the Principal Cities of New York State (illustrated); John C. Trautwine, Jr.—Steel Templates for Making Joints in Concrete Sidewalks and Curbs; C. R. Mandigo—The McCall Ferry Power Plant; Mason D. Pratt—Notes and Queries.	
ENGINEERING NEWS OF THE WEEK....	27
PERSONALS....	28
ENGINEERING SOCIETIES....	28

Engineering Features of the Alaska-Yukon-Pacific Exhibition.

The Alaska-Yukon-Pacific Exhibition at Seattle, Wash., which is intended to illustrate and give publicity to the commercial and industrial development of the Pacific Northwest, was opened on June 1 with appropriate ceremonies. The exhibition occupies a site of about 260 acres, with a frontage of one mile on Lake Washington (25 miles long) and ¼-mile on Lake Union (5 miles long). The natural scenery, with neighboring mountains and forests, is very different from that which has formed the setting of most of the previous exhibitions in this country.

The principal buildings include the following: Agriculture, Manufactures, Machinery, Fine Arts, Administration, the Auditorium, Forestry and U. S. Government (this last including a main building and two separate buildings for Mines and Fisheries). There is also a Power Station, and there are numerous state, foreign and other buildings. A special feature here (as at the St. Louis Exhibition of 1904), is that some of the buildings are permanent structures. These will be used by the University of Washington after the close of the exhibition. They were illustrated in our issue of April 2, 1908. The Fine Arts Building will be for the Chemistry Department, the Machinery Building for the Engineering Department, the Forestry Building for the School of Forestry, the Auditorium for the University auditorium, the Washington State Building for the library, and the Power House for the university power plant.

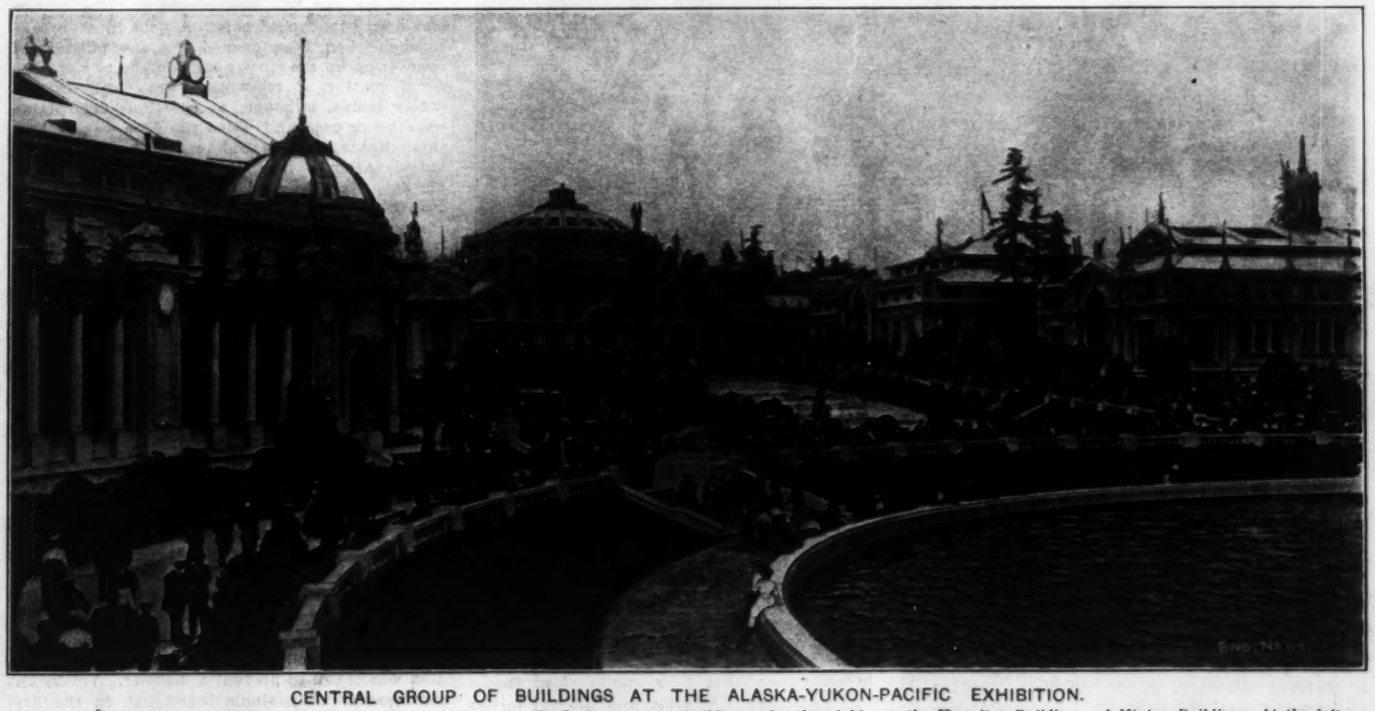
The permanent buildings have brick walls, and interior construction of different types; the Fine Arts Building has a steel frame and reinforced-concrete floors; the Auditorium is of steel and slow-burning construction, and the Machinery Building is of heavy mill construction. The temporary buildings are of the type of construction generally employed for such structures. They have wooden footings, posts, girders, floors and roofs, with "staff" and cement exterior covering and decorative work. The supervising architects of the permanent buildings were Howard & Galloway, of San Francisco. The architects for the other buildings were Bebb & Mendel, Saunders & Lawton, and Somerville & Cote, all of Seattle.

The city being unable to furnish the exhibition with the amount of water needed, the exhibition company installed a pumping plant of its own, and two water-supply systems. The pumping station is at Lake Washington and has three units each with a capacity of 1,000 gals. per min.; they are Worthington centrifugal four-stage pumps directly connected to Westinghouse motors of 200 HP. From this station run two 12-in. mains for a distance of 5,000 ft., and from these are run several laterals varying from 10 ins. to 6 ins. diameter. Parallel with this system, and connected with the city pressure system, there is a drinking water system with 8-in. to 12-in. pipes, supplied by the Cedar River mains. Each of the two systems has a total length of about four miles. The pressure varies from 75 lbs. at the highest point to 135 lbs. at the lowest point, but may be increased by pumping if necessary.

For fire protection there are 75 fire hydrants distributed through the grounds. Each of these has from one to six 2½-in. fire connections.

The sewer system parallels the water supply systems, and is of the same length (4 miles). It is built of 12-in. to 6-in. vitrified pipe, with the necessary manholes and lamp holes. There are toilet rooms and lavatories in each of the buildings, and public comfort stations are placed at convenient points throughout the grounds. Garbage and refuse are removed by one of the concession companies, which takes entire charge of this matter.

For electric lighting, there is a sub-station taking current from the Seattle Electric Co.; this has four 1,000-KW. transformers and two 1,000-



CENTRAL GROUP OF BUILDINGS AT THE ALASKA-YUKON-PACIFIC EXHIBITION.

(The building in the middle [with the large flat dome] is the U. S. Government Building. On the right are the Hawaiian Building and Mining Building. At the left is the corner of the Agriculture Building, with a corner of the Alaska Building showing between it and the Government Building. The water from the Cascades, shown in the center of the picture, flows into the large basin in the foreground, in which is the Geyser fountain.)

KW. rotary condensers. The current is brought into the sub-station at 13,000 volts and transformed to 3,000 volts for distribution to the various buildings, where it is transformed in transformer rooms to 117 or 234-volt alternating current. A total of 250,000 incandescent lamps of 8 c.p. is used for the buildings. Practically all of the distribution wires in the grounds are placed underground. Current for the power plant is furnished also by the Seattle Electric Co.

The roadways and paths are paved with asphalt, having a 1-in. or 2-in. wearing surface on an asphalt binder course 3 or 4 ins. thick. There are about seven miles of asphalt paving. There is no intramural railway system.

The decorative features of the central part of the exhibition include "the Cascades" and "the Geyser Fountain." The Cascades flow over a series of waterfalls (illuminated from beneath by electric lights) into the Geyser Basin. For this display there is an auxiliary pumping station having two electrically driven units. The larger pump will furnish for the Cascades about

THE AUDITORIUM BUILDING AT THE ALASKA-YUKON-PACIFIC EXHIBITION.
(This is a permanent structure, and will be the Auditorium of the University of Washington.)

10,000 gals. per min., against a low head. The other pump will furnish water at 150 lbs. pressure through a 6-in. outlet for the Geyser Fountain. No lagoons or artificial lakes have been built, as the two natural lakes provide ample water scenery.

The exhibition is about 20 minutes ride from the center of the city, and is served by five street car lines and a line of the Northern Pacific Ry., the total capacities of the electric and steam lines being about 20,000 and 2,000 people per hour respectively. There is also a 15-minute steamboat service on Lake Washington, with a capacity of 1,000 persons per hour.

The officers of the exhibition include the following: president, E. Chilberg; director-general, I. Nadeau; secretary, W. M. Sheffield; director of works, Frank P. Allen, Jr. (Engineer); assistant director of works, Louis Baeder (Architect); director of exhibits, Henry E. Dosch; chief of publicity, Welford Beaton; chief engineer of power plant, Joseph Schiffers; consulting electrical and mechanical engineer, J. R. Thompson; landscape architects, Olmsted Brothers.

PRODUCTION OF LEAD IN 1908.—The total smelter production was 408,523 tons (2,000 lbs.), which is 33,492 tons less than for 1907, a decrease of 7.6%. Of the 1908 production 310,762 tons were from domestic ores and 96,761 tons from foreign sources. The total output of refined lead for the year was 396,433 tons, as compared with 414,189 for 1907. From secondary sources 18,283 tons were recovered as compared with 25,498 for 1907. The amount of lead "available for consumption" for 1908 is given as 318,151 tons, against 373,140 for 1907. The true or the apparent consumption are not given, as the increase or decrease of domestic stocks for the year 1908 were not known.—U. S. Geological Survey Preliminary Report.

Some Simple Causes of Mine Explosions.

By L. D. TRACY,* Assoc. M. Am. Soc. C. E.

The number of serious mine explosions in the bituminous regions of Pennsylvania and West Virginia in the last three years has aroused the mining engineers and operators to a close investigation of their causes. The Federal Government has established a laboratory where many interesting tests of explosives, firedamp, dust, etc., have been made, and much valuable information will doubtless be obtained. By reports from eminent mining engineers, mine inspectors, and operators, the scientific and technical side of the question has been emphasized. But there remains another side, which for the sake of a better name we might call the "human side."

It is a well-known fact that no matter how well equipped a mine may be, or how many precautions may be taken to prevent disaster, they may all be set at naught by the ignorance, or carelessness, of a single individual. "A chain is no stronger than its weakest link." The weakest link in the chain of operations in a mine is made so by the inability of the average foreign miner to understand the precautions and to obey the rules prescribed for his safety.

That such a seemingly small matter as an open door between two different air currents may cause a disastrous explosion with its accompanying loss of life was forcibly illustrated to the writer a few years ago. The mine in which the incident took place was situated in the Pittsburg district, and while gas was known to be present, the ventilation was sufficient to dilute and carry it away. However, the trapper boys, employed to look after the door, had gone out on a strike for some trivial cause leaving the drivers to open the doors themselves. These doors were so hung, as in all mines, that they would close themselves by gravity. The mine was laid out in the so-called "panel system" as shown by the accompanying figure.

The main entries were driven quartering and from these pairs of face entries had been driven at intervals of possibly a thousand feet. From these face entries, known as Second North and Parallel and Third North and Parallel, butt entries were turned in such a manner that those driven from one pair of face entries would meet those turned from the other pair. Each section was ventilated independently. The air going up the Main and Left Main Entries, split at Second North Parallel, part ventilating this section of the mine and the remainder circulating through the Third North and the face of the main entries. Reference to the accompanying figure will indicate more clearly the system of ventilation used. A pair of entries from Second North had met the corresponding pair driven from Third North and brattices with doors had been erected to preserve the original scheme of ventilation. Now, owing to the grades, nearly all the coal was hauled to Third North and thence to the main-haulage system. The writer in passing through this entry noticed that the door (marked "A" in the illustration) had been left open. Apparently, a driver in passing through with his trip had neglected to remove the block which had been used to keep the door from closing while the trip was passing through. This caused what might be called a "short circuit" of the air current, completely shutting off all ventilation from the face of Third North Entry, Third and Fourth West and the main entries, as may be seen from Fig. 2. This caused the collection of gas at the face of these entries. In some manner this became ignited by the miners driving the faces of the entries and they were severely burned. How long this door had been left open is unknown, probably for a comparatively short time. There were practically no rooms turned from these entries but it is not very difficult to imagine circumstances in which a number of working places might have been turned, each one giving off gas ordinarily removed by the ventilation, but which in this case would have accumulated. Had the door been left open any length of time, the chances for a disastrous explosion would have been great.

A somewhat similar occurrence of gas was found in an adjoining mine several years later. A party of engineers were making a survey of the mine and were working near the face of the main entries. Before beginning work, an examination for gas had been made and the entries had been pronounced safe. A door in a "breakthrough" had been opened, for the purpose of connecting up the survey lines in the two entries. As a matter of precaution, the party carried safety lamps, although, at the time, open lights were being used and, when the door was opened, these lights were placed on the bottom of the entry. After a time the instrumentman lifted his open light to read the angle recorded in his transit, but before he raised it to the level of the vernier plates, he replaced it on the floor and tested for gas with his safety lamp. Enough was found to have collected in that short space of time to have burned them severely. A year or two later an explosion did take place and caused the loss of a large number of lives. In a report upon this last named explosion made by an investigation committee for the company, this sentence is found, "We are of the opinion that there was some disarrangement of the ventilation permitting an accumulation of explosive gas prior to the explosion."

Had an examination of the entries been made previous to the opening of the door, referring to the first of the two incidents mentioned, it would have failed to disclose sufficient gas to have been considered dangerous. It would seem that these occurrences might throw light on many of those disasters in which a mine apparently had been free from gas.

Both mines in which these two incidents occurred were well ventilated and every precaution was taken to prevent a disaster. Yet by the carelessness of a single individual, in the first case, all of these precautions were neutralized. The second case is the antithesis of the first, as had the instrumentman been less careful, there might have been serious results. It might be here remarked that later this same engineer became a mine superintendent and lost his life by an explosion while trying to remedy some defect in the mine, before allowing the miners to enter. This is another instance in which heavy loss of life was prevented by the carefulness of one man. If life was saved by the watchfulness of an individual in one case, conversely, why should not a part of the present large loss of life occur by the heedlessness of ignorant miners in many cases?

The inability of the average miner in the bituminous mines to properly understand the dangers involved in his work is well known and in the report of the Pennsylvania Department of Mines it is stated that 41.19% of all the fatal

*Civil and Mining Engineer, 245 Fourth Ave., Pittsburg.

accidents in the bituminous mines were due to the carelessness of the victims themselves and that 36.1% were due to the carelessness of others.

The following occurrence, illustrating this statement, came to the notice of the writer. During an inspection of a mine by the State Mine Inspector, a miner, able to speak little if any English, was observed loading coal in a room where over his head and barely clinging to the roof was a large piece of slate, weighing probably over a ton. Apparently indifferent to his danger, he refused to stop work to remove the danger. His objection was that he would do it "bye and bye" when he had no more coal to load. And it was not until the official addressed him in no uncertain terms to stand from under, that he moved out of danger. The weight of a miner's pick placed between the roof and the slate was enough to bring the entire mass crashing down. Either he did not understand his danger or else his desire to increase his output of coal led him to take the risk. A miner makes good living wages, when the mines are running well, without exposing himself to such dangers; $100 to $125 can be found beside the names of many miners upon the monthly payrolls. The point to be emphasized is that if a miner, through ignorance or carelessness, will ignore a personal danger so obvious, how much more will he ignore the hidden danger of a gaseous entry or room and jeopardize the lives of hundreds of others.

Another prolific source of danger is the disregard among the foreign miners of the warnings placed at the entrance to dangerous places. Perhaps there is the semblance of an excuse for him as it is the custom in some of the mines in Western Pennsylvania, whenever a room or working place has been driven to completion and before work has been started on drawing the ribs, to place a "danger board" at the neck or entrance to the room, regardless of whether or not there is any real danger. There is a two-fold object in this: (1) To save the fire boss the labor and time of examining the rooms during his morning inspection (by the laws of Pennsylvania, a mine in which gas is known to exist must be examined at not more than three hours before the day's work begins and often the district is so large that one fire boss can cover it only in a very rapid manner and cannot give it the attention required); (2) to keep the miners from using it as a convenience. The miner soon learns that there is no real danger and he goes over it whenever he cares to and there is no chance of detection. The result is that he fails to differentiate between a "danger board" placed for this purpose and one that means real danger.

In the Darr mine explosion in which 239 lives were lost, the bodies of five miners were found at least 200 ft. beyond the fenced-off portion of the mine. In many minds this was the cause of the explosion.

The maximum penalty for carrying open lights, matches or smokers' articles, in a part of the mine deemed gaseous and so marked by danger signals, is a $500 fine, six months' imprisonment or both. In 1907 there were some 29 prosecutions for violation of laws relating to the safety of gaseous mines. Five were found "not guilty" but paid the cost of the prosecution. One was fined $56.55 for being found with an open light beyond a danger signal. This was the maximum penalty imposed. Others were let off with smaller amounts. To one accustomed to the mines, these precautions seem to hit a very small part of the violations and to give too light punishment. It is true that the circumstances of the cases are not known to the writer but it seems as if a much more severe punishment might have had a salutary effect.

There is a tendency among many mine owners to drive entries many yards before cutting across the chain pillar to the parallel entry, although in the past three years the state mine inspectors in Pennsylvania have insisted in having the breakthroughs spaced closer together. An entry would possibly be driven 150 or 200 ft., the only ventilation obtained being secured by a canvass brattice built through the center of the entry. This cuts down the volume of air to a great extent. Should a pocket of gas be suddenly found, it is doubtful if the current would be of sufficient strength to carry it away or to dilute it beyond the explosive stage.

This applies to more than entries alone. The writer has seen rooms 300 or 400 ft. long with perhaps only one or two breakthroughs and often one of these would be a small hole through which one could scarcely crawl. The increase in entry and room breakthroughs means, of course, an increase in the mining cost of coal per ton and this is the main reason for keeping down the so-called "narrow work."

Carelessness of the superior officers of a mine in obeying rules established for the safety of miners is well set forth in "Mines and Minerals" for January. Here the argument is advanced that when an ignorant foreign miner sees a rule broken by a superintendent or mine foreman he thinks that he too can break the rule with impunity. Mine managers must be careful in this respect as they expect employees to be.

Much has been written recently about the liability of dust explosions and, while it is undeniably true that under certain conditions dust will ignite, it is not clear to the writer that these conditions are to be found in the average mine. In one who has tramped ankle deep in mud, in one who has had survey notes almost obliterated by water dropping from the roof, not much warmth can be aroused for dust-explosion theories.

It is a question, when coal dust is present, whether or not enough heat can be generated either by a blown out shot or by an electric spark to ignite suspended dust particles. The writer has never heard of an explosion of dust in any of the coal fields where gas is an unknown quantity and it seems probable that there must first be an explosion of fire damp.* It is the belief of the writer that, if the explosive gas in a mine is thoroughly removed, the danger from dust will be largely eliminated.

One of the greatest, if not the greatest, of the problems that mine owners have to deal with is in procuring more intelligent and efficient miners. This is a serious question in the bituminous regions where the demand for coal is so great that any tendency to decrease the number of available miners is opposed by the operators, as it seriously lowers the output. In the 1907 report of Pennsylvania State Department of Mines we read:

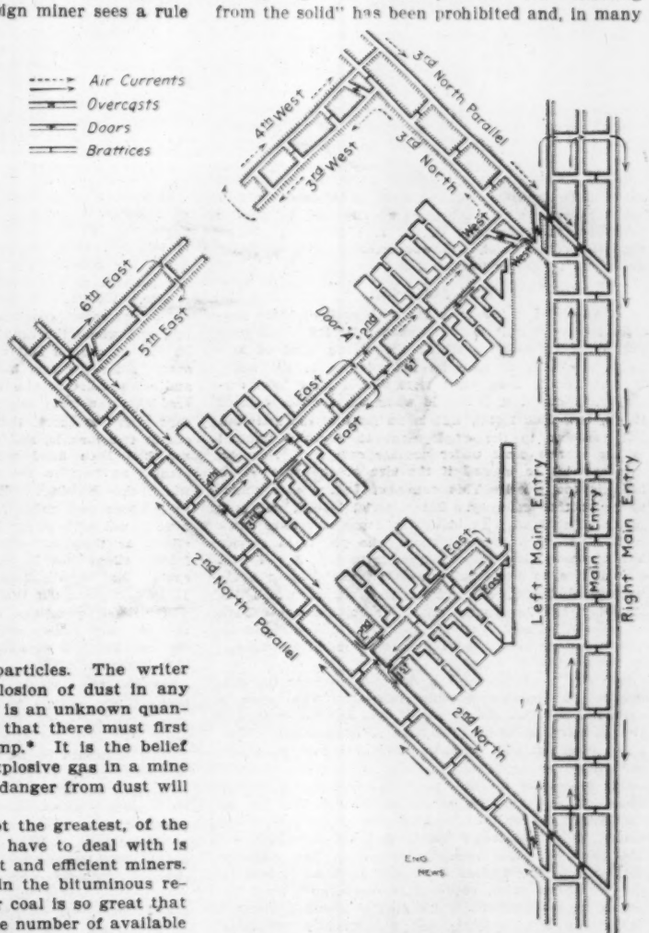
> No doubt a stringent law could be enacted that would prevent wholesale disasters by gas and dust in bituminous mines, but how to make a law that will compel superintendents, foremen, and other employers to do their duty, and that will also keep ignorant men from being employed in dangerous mines, is a harder problem. The mines of this state are getting deeper, more gaseous and more dangerous while the employees seem to be getting more incompetent to take care of themselves. When it is considered that between 60% and 70% of the inside employees cannot speak or understand the English language, it is no wonder that there is a great loss of life.

In the anthracite mining laws of Pennsylvania, it is stated that

> no person whosoever shall be employed in the anthracite coal region of this Commonwealth, as a miner in any anthracite coal mine, without having obtained a certificate of competency and qualification so to do from the "Miner's Examining Board" of the proper district, and having duly registered as provided herein.

This law is not entirely satisfactory as there is more or less illegal trading in certificates. But it would seem that it is more beneficial than none at all from the following statement: From 1901 to 1907 there were employed inside of the anthracite mines 852,576 persons. The number of fatalities from gas or dust explosions was 267 in the same period—one death to every 3,193 employees. In the bituminous mines for the same period there were 976,913 persons employed inside and 677 fatalities from gas or dust explosion—one death for 1,441 persons. That is, over twice as many fatalities from gas or dust explosions occurred in the bituminous regions where there are no qualifications than in the anthracite regions where an examination is required.

One of the most successful innovations in gaseous mines has been recently introduced in the coking regions of Pennsylvania. All "shooting from the solid" has been prohibited and, in many mines, experienced men have been employed to do all shooting after the majority of the miners have left the mine.



SECTION OF A PENNSYLVANIA MINE, SHOWING CHANGE IN VENTILATION BY OPENING A SINGLE DOOR.

The largest number of fatalities, however, does not come from the great disasters, although these are the ones brought to the notice of the public. It is the multiplication of individual accidents which contributes the greatest number of deaths and these are principally due to ignorance or carelessness.

It would seem that if some method could be devised whereby the standard of intelligence of the foreign miner could be raised without causing a great deficiency in the labor supply, a long step in the direction of safety would be taken. At least, no one should be permitted to work in a gaseous or dangerous mine who cannot speak the English language intelligently.

American mining has been contrasted very unfavorably with foreign practice. Yet the statistics may be studied from a more favorable view-

*Mr. Frank Haas in a paper read before the West Virginia Mining Association, at Charleston, W. Va., Oct. 7, 1907, and reprinted in "Mines & Minerals," December, 1908, treats this subject very thoroughly.

point. From 1897 to 1906 the average number of lives lost in Pennsylvania for every 1,000,000 tons of coal produced was 3.76. In Great Britain for the same period the average loss of life, for the same amount of coal mined, was 4.35 and in Belgium it was 6.14. When the fact is that such a large number of persons employed in America are unable to speak our language this comparison is more favorable than is generally supposed. If the foreign miner can be educated to a better sense of the dangers involved in this work and impressed with a deeper sense of the responsibility resting upon him in regard to the number of lives which are at his mercy, we ought to reasonably expect a still better showing.

Failures of Engineering Works: Causes and Remedies.*

By CHARLES B. DUDLEY,† Prest. Am. Soc. T. M.

Few fields of study are more fruitful of results and lead to more genuine progress than a study of the causes of failures. Such studies may be unpleasant and disagreeable, they may at times be even disheartening, but the man who would make substantial advances must heed the lessons which his failures teach. "The scrap heap is the place to learn."

FOUR CAUSES.—In our studies of failed and broken parts in connection with our work at Altoona for now some years, we have been gradually led to ascribe failures to one or more of the four following causes, viz., to bad material, bad workmanship, bad or faulty design or to unfair treatment.

Bad Material.

Let us spend a few moments with each of these possible causes of failure. First, bad material. This does not cover those cases where the wrong kind of material was used or material not adapted to the work. If cast iron is used when steel should have been employed, if the steel is brittle when the service requires tough, tenacious metal, this is no fault of the material. Failures due to the employment of material unfitted to the service come under another category. Nor can the material be blamed if the size of the part which fails is too small. This cause of failure also comes under another category. But material is bad, and may justly be charged with being the cause of failure when it is different from what those who put it in service had a reasonable right to expect it to be. A rail with a bad pipe in the head, an axle made from a badly segregated bloom, a piece of concrete in which the materials are improperly mixed or contain not enough or inferior cement, are all examples of bad material, and if failure comes the failure may justly be charged to the material.

But why is there ever any difficulty between the producer and consumer about material? The price is agreed upon when the order is taken and the quality of the material is either specified or understood. Why, then, does not the producer always furnish good material?

Our experience on this point has brought us face to face with several explanations of the difficulty we are considering. First and perhaps most important is the price. It is constantly urged that the consumer will not pay the price requisite to secure the materials desired. No information is usually given as to how far the wished-for price, requisite to secure such good materials as the producer would like to furnish, covers a desire for large profits, and consequently consumers have always been a little slow in attaching much weight to this excuse. Prices are largely determined by competition, and in the absence of something more than a verbal statement from the producer that better materials would be furnished at a higher price, he would be a bold purchasing agent that would pay the higher rate. On the other hand it is undoubted that competition is the antagonist of quality, and where materials are bought without reasonable specifications rigidly enforced there is unquestionably much weight in the contention of the producer.

Another reason or excuse for poor materials is that processes and methods of manufacture do not always and every time yield the desired first quality product. Strive as the manufacturer may, the works always turn out some material that is inferior. Taking one illustration from the steel industry, it is well known that every heat is not equally as good as every other, and that a part of each ingot is inferior to the remainder of it. Of course, all of this inferior part that cannot be sold must necessarily remain as scrap, to be worked over again, with the result that the manufacturing cost of the marketable product is necessarily increased. Hence the tendency to crowd the limits and force upon the purchaser all the merchantable material possible, even though some of it may be inferior. It is fair to say that there is a good deal of human nature in this phase of our subject, and if only those of us who are without sin are entitled to cast stones we greatly fear very few stones will be thrown.

Another and most pernicious excuse for furnishing bad materials is the attempt so common everywhere on the part of producers to usurp the legitimate functions of both the consumer and his expert. This manifests itself in the statement, so commonly made by those furnishing material, that it is good enough for the purpose, thus arrogating to themselves the right to decide not only how the material shall be made, but also what kind of material the consumer and his engineer shall use. We are entirely ready to allow that the study of materials, during both the process of manufacture and their behavior while they are in service, is a legitimate field of activity for both producer and consumer, and, as is well known, we have persistently urged with all the force that we were capable of, that while specifications are being made there should be the heartiest cooperation on the part of both. But the specification having been decided on and the contract placed in accordance therewith, there really seems to be very little room left for excuse for furnishing materials that do not meet the requirements, because they are, in the judgment of the producer, good enough for the purpose.

Bad Workmanship.

That bad workmanship is a far too frequent cause of failures is common experience. The tendency to slight the job is almost universal. A rivet or a bolt is left out, with consequent increased strain on those which are actually put in, a forging does not fill out the pattern, or the metal is burned, or a weld is defective. We knew a case once where the construction on a passenger coach involved the safety of human life, and where the drawings required that there should be two nuts on a bolt and the end of the bolt riveted over. After the cars had been in service a few weeks and some minor repairs were being made, it was discovered that the bolts originally used in a number of the cars were too short, that the second nut only grasped one or two threads, and that the remaining space in the nut had been filled with putty, so manipulated and stained as to give the appearance of the riveted end which the drawings called for. We knew of another case where two ends of a gas pipe in a small house were joined with putty, instead of with the well-known sleeve or thimble. Fortunately the odor of the gas from a slight leak in the defective joint led to its discovery and repair before anything serious happened. There is little doubt that the experience of each of you will furnish quantities of cases of bad workmanship, and we have known engineers who did not hesitate to declare that bad workmanship was the principal cause of failures in service.

ITS CAUSES.—Those of you who have frequently been brought into contact with the results of bad workmanship have no doubt, like myself, often wondered why work was so badly done. Not infrequently in contemplating a failure in which bad workmanship played an important part, we have said to ourselves, "there was absolutely no excuse." And yet since workmanship is so important an element in our theme, it may not be amiss to go a little deeper into the matter. Every one will recognize lack of skill, general inefficiency and simple plain laziness as important elements in bad workmanship. But since these are individual characteristics it probably would not yield any valuable results to discuss them. It is true the apprentice system or lack of apprentice system which is characteristic of many trades might, perhaps, justly be blamed for lack of skill, but it would lead us too far to consider this point.

LOW PAY.—No doubt many will claim that inferior or insufficient compensation is the most fruitful cause of poor quality of work at the hands of those who, in our industrial system, play the part of hewers of wood and drawers of water. But if we are right, the experience of the last few years has not seemed to confirm this view. If this was the real explanation it would seem to necessarily follow that voluntary increase in wages would bring an increase in efficiency. On the other hand, if we may trust the indications that we have been able to gather, the increase in efficiency following voluntary increases in wages has been most disappointing. We must apparently look further for the real reason for poor workmanship.

METHODS OF PAYMENT.—In our judgment, the method of compensation for work performed has a direct and most important influence on the quality of the service rendered. We refer especially to the piecework system in those places where it is applicable, and to the payment of all interested in proportion to the amount of successful output, which is so common in the steel industry. Both these methods of compensation stimulate output at the expense of quality, and it is not at all strange, perhaps, that after constructions have found their way into service, we should frequently find evidences of the haste, the slighting over and the inferior workmanship which these methods have necessarily done so much to stimulate. We are not at all prepared to suggest any substitute for them, and we are, and have been for many years, an admirer of them from the standpoint of successful management, but it is folly for us to close our eyes to the fact that the piecework and other successful output methods of compensation of workingmen are antagonistic to quality of work, and that, despite all our efforts to the contrary, they may justly be held responsible for some of our engineering failures.

LABOR ORGANIZATIONS.—One more phase of the workman problem. Close observers of the modern workman have noticed for some years a growing tendency on his part to manifest less and less interest in his work. Esprit de corps, pride in his work, and a genuine feeling of loyalty and devotion to the establishment of which he forms a part are gradually becoming less and less. The allegiance of the workman, under the influence of the ferment and agitation which now pervades our whole industrial system, is gradually passing over, in a measure at least, to the labor organization. Instead of cooperation there is ofttimes antagonism. Instead of zeal and earnestness on the part of the workman to do his best there is study how to make the organization stronger and secure greater benefits for himself. The effect of this transfer of allegiance on the quality of the work performed needs no elucidation.

It is not at all our purpose to discuss the labor problem, and this statement of the situation is cited only because it throws a valuable side light on the question we are considering. We may, however, be permitted a single statement, viz.: We are firmly convinced that if labor organizations would devote less time and energy to contention with employers and more effort toward making the organization stand for skill and plain, simple honesty in workmanship, and for fair dealing with, and reasonable devotion to, the interests of employers, all questions connected with the recognition of the union would fade into insignificance and collective bargaining would be welcomed, nay, even sought for, by those who are managing the great industries of our modern civilization.

Bad Design.

Third, it is evident that the engineer who makes or finally decides upon the design of any structure carries a heavy load of responsibility. He is first in the field and practically tells all who follow what is to be done. He must decide not only the kind of material that is to be used but also the amount or sizes, and how it shall be disposed. His realm embraces every kind of structure, from the foundations of a bridge or building to the most minute detail of a locomotive or car. In railroad track he says or should say what weight of rail shall be used, the number of ties per rail, and the kind and depth of ballast. His knowledge of the properties of materials used in construction must necessarily be broad and comprehensive, and the field is so enormous that there are naturally numerous specialists, each being able to cover, and be an authority in, only his own little paddock.

The engineer who makes the design labors under two very serious difficulties. First, it is not possible, many times, to compute the strains to which the whole or parts of the structure will be subjected. Perhaps we can make this point clear best by considering the locomotive driving axle. The strains produced, when we regard the locomotive as a vehicle, are simple and easily determined. So likewise the bending moment produced by the action of the steam on the piston, as well as the torsion strain produced by the crank. But who can tell the bending moment produced by the lurch when the wheel strikes a curve at high speed? Who can even give a guess at the strain produced when the brake is applied, making an emergency stop at 60 miles an hour? Moreover, the tendency of the times is toward larger and larger structures. And as the parts increase in size, would any of us be willing to say that the strains in each part would increase directly proportional to the increase in size of the whole structure, or that a proportional increase in size of any given part would so successfully meet the increased strains as did the corresponding smaller parts of the original structure? The engineer who makes the design, perhaps more often than any of us, is at the end of his knowledge, and if failure comes due to defective or faulty design deserves, in our opinion, more sympathy than any one else involved.

But the designer labors under another serious difficulty. He is often overruled and prevented from doing what his judgment prompts him to do, in the interests of safety, by those who control expenses. The construction he would like to use costs more, and the management for economic reasons demands something less expensive. Of course, under these conditions, much responsibility is taken off the designer. And while we are ready to allow that some check is desirable, since those who make the design are, after all, human and naturally will take care of themselves, we cannot but

*Abstracted from the Presidential Address before the American Society for Testing Materials, entitled "Engineering Responsibility," read at Atlantic City, N. J., June 29, 1909.

†Chemist, Pennsylvania R. R., Altoona, Pa.

feel that this check should be sparingly applied in all places where safety to human life is involved.

Unfair Treatment.

Fourth, unfair treatment. As already indicated, there is a natural disposition on the part of each of us to relieve ourselves from blame and put the fault on some one else, and if our observation is worth anything there is no field of parceling out deserts among those involved in failures and the responsibility therefore more fertile than this one of unfair treatment. This field is the especial paddock of the maker or producer of material. If a rail breaks or fails in service there was, says the rail maker, something wrong with the track or with the locomotives or cars that run over it. If a car wheel breaks or fails to give the guaranteed mileage, the track was too rough, the use of the brakes too severe or the lading too heavy, and so on. Far be it from us to say that unfair usage is not many times a legitimate explanation of failures. If a freight locomotive, designed to haul a heavy load at 20 mi. an hour is used at times on a passenger train at 40 mi. an hour, and in so doing shakes herself to pieces, the fault is certainly not in the materials nor in the workmanship, nor in the design, but in the unfair use. If, due to the growth in size of locomotives and cars, an old iron bridge, designed for not over two-thirds the live load which is actually put upon it, gives way and produces a disaster, the responsibility rests with the operating officer rather than with the bridge engineer.

There is, however, another phase of this part of our subject. Unfair treatment is very much broader than the obvious misuse of a bridge or of a moving vehicle. The materials entering into a structure may be unfairly treated. If the calculated strains are too high, or, what amounts to the same thing, too low a factor of safety is employed, materials are unfairly used. Still further, where a structure is a composite it may, and undoubtedly does, often happen that the elements making up the composite are unfairly treated, as when, for economic reasons, not enough money is spent to properly install the structure. For example, a steel rail called upon to do its work supported by too few ties, insufficient ballast and a badly drained sub-grade, is unfairly treated. Moreover, the state of repair in which structures are maintained is clearly an element in their fair treatment. If not enough money is spent in repairs and parts become weakened by decay, corrosion or wear to such an extent that failure results, it is entirely obvious that the failure must be attributed to unfair treatment.

A Divided Responsibility.

It is evident that, since the four parties involved in successful construction—the designer, the producer of material, the workmen and the user—have different individualities and may have diverse and even antagonistic interests, there is abundant reason why there should be an attempt to shift responsibility for failure. And, indeed, we might perhaps safely go a step further and say that there is abundant reason why each of the four parties should try to limit the part which his own work plays in the final result, and say plainly, if the other three had done as they should there would have been no failure. The man who furnishes the material is tempted to say, "If the designer had allowed a proper factor of safety everywhere, if the workmen had done their duty, and if the structure had received only proper fair treatment, almost any material would have been good enough." The engineer who makes the design is tempted to say, "if the material had been what I had a right to expect it to be, if the workmen had done good work and there had been no abuse of the structure in service, there would have been no failure." And so on, for the others. It is plain that the problem of obtaining successful constructions is a complicated one, and that the chances for divided responsibility which are involved are no small element in this problem.

Where Improvement Is Possible.

Let us now devote a few moments to precautions that may be taken with material and workmanship in the interests of safety; and to a consideration of what should be our mental attitude toward design and unfair treatment. And first as to workmanship.

WORKMANSHIP: BETTER SUPERVISION.—Under present conditions the necessity for close supervision is evident. Managing men everywhere recognize this necessity and are employing all means at hand to secure it. We knew an officer of a large corporation some years ago who said to his board of directors: "If you will allow me to spend $50,000 a month more in salaries, so that I may give your work better supervision, I will give it back to you four-fold." Moreover, with the growth of modern industry and especially with the development of machinery as an element in this growth, the individuality of the workingman has necessarily diminished, and the present industrial ferment of strikes and lockouts, with their accompanying riots and violence, is, as we interpret it, the revolt against this debasement of individuality. That the revolt should at times go too far, that unreasonable demands should be made, that demegogues and agitators for their own advancement should get into positions of prominence, is perhaps to be expected. As time progresses these will pass. It takes time to bring a change of views in both employed and employers. Already there are signs of something better and our belief is that in the not far distant future, as the result of wiser management on the part of labor organizations and reasonable concessions on the part of employers, there will be a return by the workingmen to the old-fashioned virtues of interest and pride in their work, and unswerving loyalty to the organizations which they serve. The effect of this change on the quality of workmanship needs no comment.

MATERIALS: CAREFUL SPECIFYING AND TESTING.—Second, with regard to material. It is difficult for us to see how any one who is responsible for safety in structures dare at the present time put material into these structures which has not been bought on carefully prepared specifications, and which, before acceptance, has not been rigidly inspected and tested. In time past, before consumers understood the demands which the service makes on materials, the reputation of the maker was perhaps the best safeguard known for good materials and was accepted as reasonable defense in the investigations following disaster. But in these days, when the service has been so frequently questioned, when so much accumulated information is available, when experts and facilities for testing are so largely multiplied, we cannot help feeling that the management that puts materials into service, especially where safety is involved, without careful and conscientious inspection and testing, is taking a risk that it is no longer entitled to assume. It is gratifying to be able to see that, as the years go by, there is constant and steady growth in this field.

FAIR TREATMENT OF MATERIAL: COOPERATIVE STUDY.—But how about the unfair treatment of materials, or the structures made from them? Here no supervision beyond some meager legislative enactments and the condemnation of public opinion in case of disaster, is possible. It is, of course, true that those in charge of the construction and operation of utilities in which the public safety is involved are constantly face to face with the possibilities of heavy losses in the way of damages for accidents, and no doubt this is a most powerful check against unfair treatment. But it has seemed to us for a long time that the producers of material have far too much neglected their opportunities. What we have in mind is that careful studies and investigations should be made by the producer, leading up to demonstrations if possible. It is common experience that the truth is reached with much greater certainty and speed if a problem is attacked by two parties who approach it from different standpoints and are actuated by antagonistic interests. Our whole Anglo-Saxon jurisprudence is founded on this method of procedure.

DESIGNING: FULLER TEST KNOWLEDGE.—Fourth, what shall we say of the engineer who makes the design? We have already described his difficulties, pointed out his limitations and expressed our sympathy with him in his chance failures. It remains to put on record a few thoughts which have forced themselves on us, not once but many times, while preparing this paper, as especially when contemplating the difficulties of the engineer who makes the design. The truth is we are using materials in construction without sufficient knowledge. There is crying need for experiment. Testing machines, adequate to cope with some of the problems which now confront engineers, do not exist. We are increasing sizes and constantly building larger structures. If the test of service gives a failure it simply proves that our guess as to the increase needed was wrong; and if the test of service shows freedom from failure we still do not know that we have used material wisely and economically. The factor of safety everywhere is largely a guess. The late A. L. Holley, one of the brightest mechanical engineers in this country 25 years ago, used to speak of "the ridiculous factor of safety, one-half of which is a factor of ignorance." We cannot help feeling that no better use could be made of some small fraction of the millions that have been accumulated by individuals in connection with our great industries during the past half-century than in the establishment of a Bureau of Engineering Research. Who will avail himself of this magnificent opportunity?

Personal Conscientiousness.

Just a word in conclusion. No one, I am sure, can contemplate the situation which we have been trying to discuss without being impressed with the diverse and ofttimes antagonistic interests involved. The foundations of these diverse interests are of course very deep, and with the present organization of society it is not easy to see how they are to be obliterated or their antagonism neutralized. But we beg to make one suggestion. Would not an infusion of genuine conscientiousness into our industrial life bring an amelioration? If a little less energy was expended in the mad race for wealth and a little more zeal manifested in maintaining the rugged virtues of honesty, integrity and fair dealing, would not some of the friction and contention of our present commercial life disappear? We must all live together, and surely harmony is better than contention. There are some things in life of more value than money.

An Attempt to Destroy Canal Lock-Gates By Dynamite.

In the discussion concerning the type of canal at Panama, more or less has been said concerning the possibility of malicious injury to the locks and their appurtenances by dynamiters. It is of some interest, therefore, to record what actually happened when an attempt was made some nine years ago to injure a lock on the Welland Canal. The circumstances, as obtained by us from official sources, were briefly as follows:

In April, 1900, two men, named John Walsh and John Nolin, together with a confederate, Karl Dullman (who was afterward found to have been the real principal in the affair), carefully examined the Welland Canal with the object of perpetrating injury upon it. They spent about two weeks in this examination, making their headquarters at Niagara Falls, N. Y., and afterwards at Niagara Falls, Ont. On the evening of April 21, 1900, a little before 7 o'clock, these two men arrived at Thorold, Ont., by the Niagara, St. Catherines & Toronto Ry. Each of the men carried a satchel containing dynamite, with a fuse attached. They walked over to Lock No. 24 on the Welland Canal, one of the men going to the foot-gate on the heel-path side of the canal and the other to the head-gate on the same side. It was still broad daylight and a young lady standing on the bridge watched the men, supposing that they were workmen having something to do with the canal operations.

Each of the men tied a rope to his satchel, lighted the fuse, and lowered the satchel down to the water behind the gate in the corner near the hollow quoin. The charge behind the foot-gate went off first, and the watchman, who was sitting in the lock shanty on the opposite side near the center of the lock, looked out and saw the two men running away. Before the second charge exploded, he had time to telephone some particulars of what happened. The explosion of the second charge broke the telephone connection.

The lock where the explosion took place is 45 ft. wide, with a 14-ft. lift. At the time of the explosion there was a head of water of about 6 ft. against the upper gate and 8 ft. against the lower. The gates were of solid timber construction and about 22 ins. thick at the point of the explosion. The gates are made by placing one bar on top of another for the full height of the gate. The bars are of white pine, are doweled together with 3-in. oak dowels, and tie-rods of 1½-in. iron extend from top to bottom of the gate. There are besides this vertical binders of oak at the heel and toe of the gate.

The intention of the dynamiters was evidently to destroy these gates and allow the water in the level above to rush through the lock into the level below. Had their efforts been successful, very serious damage and probably loss of life would have resulted, as the canal level above this lock is a mile in length. The water would have overflowed the banks below, washed out the Grand Trunk Ry., and probably carried away the railway station and done much injury in the town of Merritton.

But the dynamite in exploding did very little damage compared with what those who placed it anticipated. It simply blew a hole about a foot in diameter through each gate, displaced the gate hangings, and broke some of the through rods. Enough injury was done to the gates to make it advisable to replace them; but the gates remained in position, holding back the water, and no damage of any importance was done to the masonry of the lock walls or the lock bottom. As navigation on the canal had not opened at the time, there were no delays to boats.

The men who placed the dynamite were promptly followed by a posse and were arrested,

with their confederate, at Niagara Falls, Ont. They were tried in Welland on May 24 and 25, were found guilty and sentenced to the penitentiary for life. One of these men died in the penitentiary on March 4, 1909.

The point of chief interest in the whole occurrence is the very trifling damage which the dynamite explosion did to the lock-gates, notwithstanding the fact that these were of comparatively small size and of primitive wooden construction. It is, of course, well known to those accustomed to the use of dynamite and similar high explosives, that the effect of an explosion in rending and tearing a steel structure is extremely local, unless the explosive is confined; and even then it is necessary to distribute the explosive in many charges in order to break up a structure of large size.

A Reinforced-Concrete Viaduct With Some Structural Steel Reinforcement, Takoma Park, Md.

The viaduct shown in the accompanying cuts has just been built to carry a highway, Carroll St., across a deep, practically dry gorge, in the town of Takoma Park, Md., just outside of the District of Columbia. For the crossing, approximately 300 ft., there was available only $15,000, so that low cost was the prime requirement in the design. To meet this economy and at the same time to provide a permanent and strong structure, the concrete viaduct was decided upon as the most advantageous, and to ensure the stability of such a viaduct, structural steel members were used as the basis of the reinforced-concrete beams and struts wherever possible. This use of I-beams distinguishes the viaduct from similar structures that have been built.

The Takoma Park viaduct consists of three 24-ft., five 30-ft. and two 24-ft. girder spans, supported on battered column bents interbraced alternately by longitudinal struts (Fig. 1). The floor is a 3-in. tar-macadam roadway 16 ft. wide carried on a slab, which has a thickness of 9 ins. along the center line of the bridge and 7 ins. along the outside, giving a transverse grade of 2 ins. to the roadway. The slab in turn rests on transverse beams, 6 ft. c. to c., spanning the 12 ft. between the main girders and overhanging 3 ft. on each side. It is designed for a live load of 100 lbs. per sq. ft., with a concentrated load on the floor system of a 15-ton wagon. If at some future time a street railway crossing is planned, the introduction of a middle line of girders and columns will provide for a 80-ton car.

The tower bents (Fig. 2) are composed of two posts, 18 × 18 ins. square at the high bents and 15 × 15 ins. at the low, spaced 12 ft. c. to c. at the girders and extending on an outward batter of 1:6 to spread foundations on solid rock. These posts are concrete reinforced at the four corners by straight round rods, encircled every 12 ins. with ¼-in. wire. Each tower is braced in itself and to the next tower in one direction by horizontal struts, made up of I-beams, of varying size, encased in concrete. These beams, the largest 12-in., 31.5 lbs., the smallest, 9-in., 21 lbs., are bolted together at each post so as to form a square in the horizontal plane of each brace. This bolted connection is shown in the detail on Fig. 2. In addition at the point of intersection of the brace with the post, there is provided a concrete bracket, reinforced with flat bars bolted to the I-beams and extending down into the concrete of the post. To ensure complete adhesion of the concrete to the beams, they were wrapped with welded woven wire, as shown in the detail. At their top the tower bents are heavily braced transversely by a deep beam of concrete reinforced with rods.

The main girders are 12 × 29 ins. in section, and are formed by laying concrete around a 24-in., 100-lb. I-beam. In the 24-ft. span this I-beam is the sole reinforcement for the section, but in the 30-ft. spans, two 1½-in. round rods are added along the bottom flange of the beam. As in the smaller I-beams, the girders are wrapped with wire cloth. They are tied across the span at each bent with 1-in. round rods and to the bents by brackets enclosing flats bolted to the steel.

The floor beams and the slabs are of concrete reinforced with round rods, turned up in the ends of the former to guard against shear. The details of this construction is well shown on the cuts.

Expansion is provided at the ends of the three middle 30-ft. spans by a simple sliding joint of both girder and slabs. This joint is shown in Fig. 4.

In the design the concrete-enclosed I-beams were figured as taking the entire dead load and the live load of 100 lbs. per sq. ft. without aid from the concrete in the 24-ft. spans, while in the 30-ft. spans the additional strength of a concrete beam reinforced with two 1½-in. rods was assumed. In addition, the stiffness of the entire structure, due to its monolithic nature, adds a strength which cannot be figured, but which undoubtedly increases the factor of safety above that shown by the computations under the assumed unit stresses.

Throughout the design special attention has been paid to the continuity of reinforcement. The I-beams are all joined together by riveted or bolted connections and in addition are thoroughly tied into the brackets and adjoining beams by flats bolted to the I-beam. The longitudinal rods of the columns are wrapped with wire for a distance of at least 10-in. either side of the joint of two adjacent rods. Further study of the drawings will show that wherever the extension of the steel into adjoining members will add to the rigidity and stability of the structure such extension has been made.

In construction, a framework made from round timber cut from the clearing for the trestle was first erected and on its top were placed the main 24-in. I-beams in approximately their correct line and grade. From these beams as a run[illegible] all construction was carried on. At the [illegible] level was located the concrete mixer and con[illegible] was deposited from a hand-driven tripod d[illegible] located on the above noted beams. The [illegible] for the trestle bents were first erected, and [illegible] tween them the I-beam braces were set. [illegible] the slanting posts and top connecting beam [illegible] bents were concreted, continuing the concrete [illegible] through the brackets under the end of each [illegible]

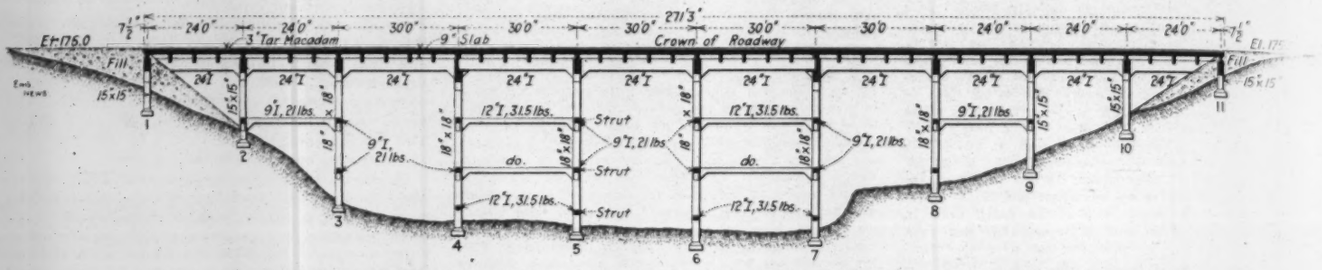


FIG. 1. LONGITUDINAL SECTION THROUGH CENTER LINE OF TAKOMA PARK REINFORCED-CONCRETE VIADUCT.

brace, but not enclosing the I-beam brace itself. Then the I-beams, both in the main girders and in the braces, were concreted, the forms being hung directly from the beams, thereby reducing the difficulties of erection and the necessity for supporting struts. Fig. 5 shows the trestle, after the trestle bents had been completed but before the concrete around the beams had been placed. A 1:2:4 concrete, with stone passing through a 1-in. ring, was used. All columns were poured for full height, but the concrete was agitated in the form by means of a 10-lb. sash-weight on end of cord.

The viaduct proper was built for $10,005, leav-

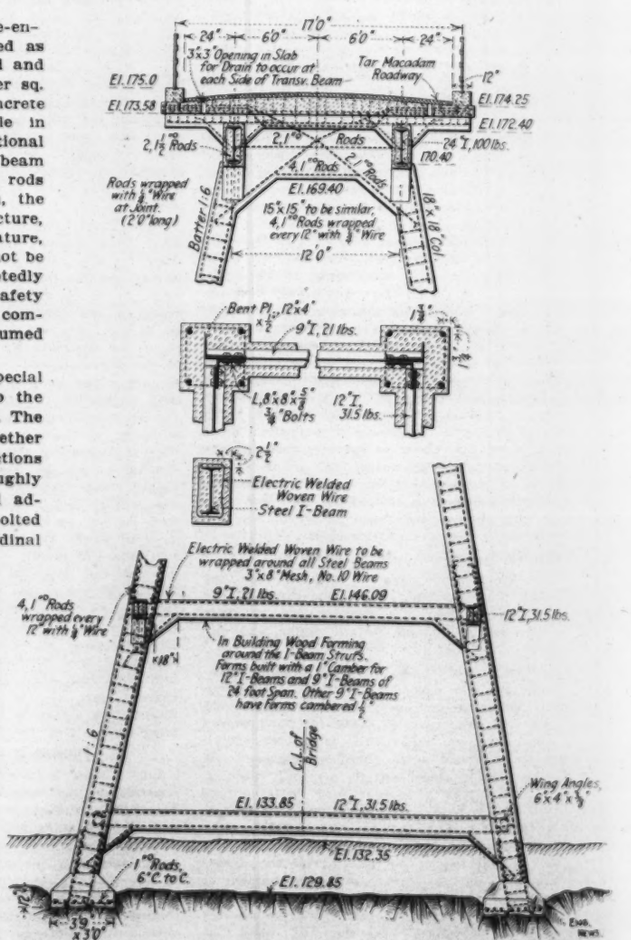

17'0"
24"
6'0"
3"x3" Opening in Slab for Drain to occur at each Side of Transv. Beam
Tar Macadam Roadway
El. 175.0
El. 173.58
El. 174.25
El. 172.40
2 1/2" Rods
2" Rods
24"I, 100 lbs.
170.40
4" Rods
El. 169.40
Rods wrapped with 1/4" Wire at Joint. (2'0" long)
Batter 1:6
15"x15" to be similar. 4" Rods wrapped every 12" with 1/4" Wire
12'0"
18"x18" Col.
Bent Pl. 12"x4"
9"I, 21 lbs.
L, 8"x8"x5/8"
3/4" Bolts
12"I, 31.5 lbs.
Electric Welded Woven Wire Steel I-Beam
Electric Welded Woven Wire to be wrapped around all Steel Beams 3"x8" Mesh, No. 10 Wire
El. 146.09
In Building Wood Forming around the I-Beam Struts. Forms built with a 1" Camber for 12"I-Beams and 9"I-Beams of 24 Foot Span. Other 9"I-Beams have Forms cambered 1/2"
C.L. of Bridge
Wing Angles 6"x4"x1/2"
El. 133.85
El. 132.35
1" Rods, 6" C. to C.
El. 129.85
3'9" x 3'0"

FIG. 2. SECTION THROUGH TOWER BENT.

ing the remainder of the appropriation to be used for approaches, fills, etc. This is a unit cost of about $2.30 per sq. ft. of roadway, a very low price considering the permanence and strength of the structure. The bridge was built for the town of Takoma Park, according to the design and under the supervision of Mr. W. J. Douglas, M. Am. Soc. C. E., by the Washington Sanitarium Association.

First Convention of the American Institute of Chemical Engineers.

The first semi-annual meeting of the newly formed American Institute of Chemical Engineers was held in and about Brooklyn, New York City, June 24, 25 and 26. Only the first day was devoted to the reading and discussion of papers, the other two days being given over to excursions to some of the chemical and manufacturing plants in the metropolitan district. Such were the Atlantic White Lead Works, the National Lead Works, Corn Products Co., Warner Sugar Refining Co., Standard Oil Co., Consolidated Gas Co. The meetings were attended by about 40 persons and the excursion parties were somewhat larger.

The discussions of the papers showed a tendency to wander from the main topics presented, due no doubt to the great difficulty of concentrating attention on technical subjects in the prevailing midsummer heat and the noise of a great city. The papers presented in the session at the Brooklyn Polytechnic Institute are abstracted below in very brief form and in the order of presentation.

Prof. W. D. Ennis, of the Brooklyn Polytechnic Institute in "Limits of Efficiency of the Power-Gas Producer," outlined the chemical reactions and thermal results in a typical suction gas producer. He showed that improved efficiency of producers was to be accomplished by reducing the sensible heat in the product. This was to be done in two ways (1) by blowing steam under the grates and (2) by blowing in some proportion of the gases exhausted from the combustion engine. In the first process, it was related, steam absorbed heat from the fuel, dissociated into hydrogen and oxygen which later went to form CO gas. The second process gave a similar lowering of initial gas temperature and economy of production by absorbing heat from the incandescent bed of coal, and the CO_2, in contact with this heated carbon, split up to CO and oxygen. The author told of the great advantage that had been found in thus eliminating hydrogen from the gas fed to the engine, allowing a higher compression, greater loading and increased engine economy.

Mr. O. K. Zwingenberger, of New York City, in his paper, "The Utilization of Low-Grade Fuels in the United States," called attention to the great number of lignite and peat deposits scattered through the country and to the work that had been done in Sweden and Germany in making peat coke and charcoal. The main details of the Zeigler process and apparatus, which the author is exploiting in this country, were described.

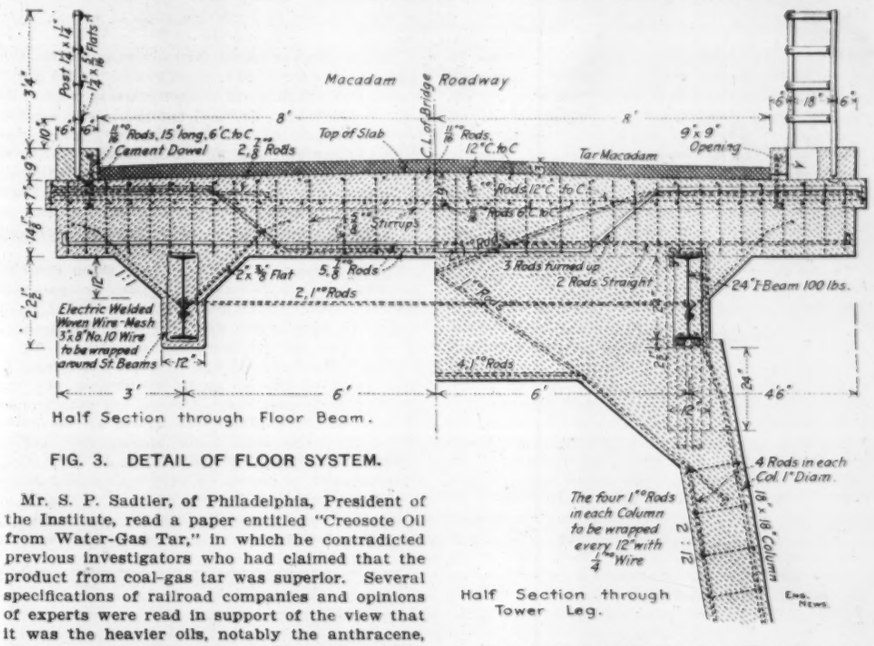

Macadam Roadway
Top of Slab
C. L. of Bridge
Tar Macadam
9"x9" Opening
Stirrups
3 Rods turned up
2 Rods Straight
24" I Beam 100 lbs.
Electric Welded Woven Wire Mesh 3'x8' No. 10 Wire to be wrapped around St. Beams
4 Rods in each Col. 1" Diam.
The four 1" Rods in each Column to be wrapped every 12" with 1/4" Wire
18"x18" Column
Half Section through Floor Beam.
Half Section through Tower Leg.

FIG. 3. DETAIL OF FLOOR SYSTEM.

Mr. S. P. Sadtler, of Philadelphia, President of the Institute, read a paper entitled "Creosote Oil from Water-Gas Tar," in which he contradicted previous investigators who had claimed that the product from coal-gas tar was superior. Several specifications of railroad companies and opinions of experts were read in support of the view that it was the heavier oils, notably the anthracene, that were effective in timber protection. The author reported the results of a series of comparative analyses on coal-gas and water-gas tar products, both made at high temperatures. He found that both were nearly free from naphthol-ene and the lighter oils, that there was 10% phenal in the coal-gas product and none in the water-gas, that the evaporation loss on long continued heating was 10% with the water-gas preservative and 80% with the coal-gas. The conclusion drawn was that the creosote oil from water-gas tar was especially suitable for wood preserving.

Mr. Richard K. Meade, of Nazareth, Pa., in the paper, "An Automatic Acid Egg," described a cast-iron "egg," in general appearance familiar to chemists, for automatically measuring and discharging acids.

Dr. C. F. McKenna, of New York City, in "The Centering of Great Industries in the Metropolitan District" described the growth of New York City, and the adjacent territory, as a port and as a great manufacturing center. He told of the great proportion of the staple articles of the country's commerce that were made in the district and pointed out some of the tendencies and possibilities of the district. The development of Staten Island, Bronx borough and the Hackensack meadows was touched upon. The author advanced two main lines of argument; one that a comprehensive power service was needed for

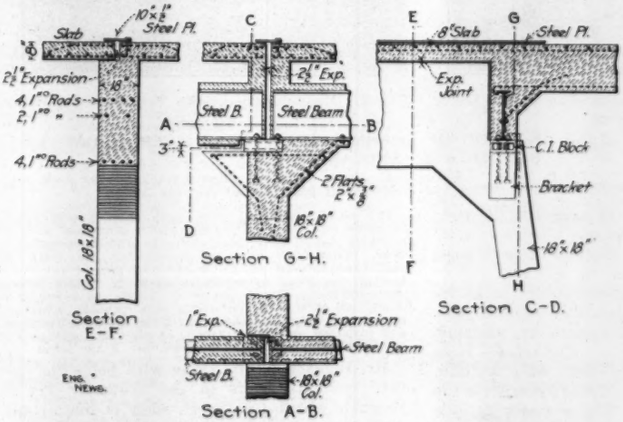


FIG. 4. DETAIL OF EXPANSION JOINT OF TAKOMA PARK VIADUCT.

FIG. 5. VIEW OF TRESTLE AFTER CONCRETING OF TOWER BENTS BUT BEFORE ENCASING OF I-BEAMS.

the district, and the other, that the present and planned water supply was inadequate in distribution and extravagant in capacity. The power he would have transmitted from hydro-electric developments on the Passaic River in New Jersey, on the upper Delaware in Pennsylvania and on the upper Hudson and in the Adirondack Mountains. The plans for a water-supply now in progress were criticised, the author favoring using filtered Hudson River water instead of that from the Catskill developments. He would have the water supplies of all this district combined under an interstate agreement.

In the paper "Experiments in the Case-Hardening of Steel with Gases," Prof. J. C. Olsen, of the Brooklyn Polytechnic Institute, related attempts to supply the lack of records of the chemical reactions and efficiency of the hardening action of gases and the function of nitrogen in the process. Low gases, water-gas illuminating, methane, acetylene and carbon monoxides were experimented with—a pressure of 4 lbs. per sq. in. being used in the furnace in all cases. The gases were tried alone and mixed with three strengths of ammonia gas. The test pieces were of soft "Norwegian" iron. It was suspected that the hardening was due to the formation of cyanogen, or some cyanides, but this was disproved. With the illuminating gas the amount of carbon absorbed by the iron was roughly proportional to the amount of ammonia gas present. With no ammonia there was no hardening. Doubling the time of heating doubled the amount of absorbed carbon and the penetration.

Methane gas gave a slight hardening, both with and without ammonia, but not as much as acetylene, though even this was inferior to the illuminating gas. The best gas of all was the carbon monoxide and the results were almost as good without ammonia gas as with. This gas was held to be the best for the purpose from all considerations.

The last paper was "Methods of Clay Control," by Mr. J. G. Dean. In a Portland cement works, with which the author was connected, it was often found that the boiling and time-of-setting tests indicated excess of clay and of free lime at the same time, though the chemical analyses indicated a proper percentage of all constituents. It was found necessary to use limestone from near the surface with the proper amounts of both clay and shale, to insure proper grinding. The arrangement of bins and conveyors to effect this was described.

Difficult Bridge Work in Great Britain.

A number of interesting pieces of bridge erection work, showing marked divergences from practice common in America, were described recently by Mr. A. S. Biggart, of the firm of Sir William Arrol & Co., Ltd., before the Institution of Engineers and Shipbuilders in Scotland. From the society's "Transactions" of last year (Vol. 52), a short summary of the work he describes has been abstracted as given below. The several bridges in question were all built by Arrol & Co., which explains certain similarities in the erection operations. On the other hand, the fact that four bridges of the group are founded on steel cylinder piers must probably be charged to the popularity of this type of pier among British engineers.

Clyde Bridge at Glasgow.

A deck truss bridge of unusual width has just been built over the Clyde at Glasgow, for the Caledonian Ry. Co. It was erected by the use of a continuous erection platform or staging extending over the whole width of the river, from which platform the foundation caissons as well as the truss work were handled. This same method was employed in all the other cases here described except the Blackfriars Bridge.

The Clyde Bridge has one span of 200 ft. in the clear, and four other spans ranging from 60 to 178 ft. The piers are granite-faced concrete above water and brick below, resting on concrete-filled steel caissons. The upper part of each pier consists of five cylindrical columns joined at the top by arches. All the caissons were sunk by the pneumatic process. The top of the caisson in each instance is several feet below the river bottom.

The erection staging had openings over the pier sites large enough to permit of lowering the caissons through them. Each caisson was built immediately over its final position; was erected on the staging to a sufficient height for beginning the sinking, and was then lowered with the use of hydraulic jacks, concrete being filled in as it went down. The brick pier shafts were built up as the caissons descended in such a way as to keep the top surface above water level and avoid the necessity of using cofferdams.

The trusses were erected at the same time as the pier building was going on. They are parallel-chord trusses, 15 ft. 9 ins. deep in the 200-ft. span and 13 ft. deep in the other spans, with a double-intersection web system, and are braced by a bottom lateral system and vertical cross-frames. The width of the bridge is not stated, nor the number of trusses, but as there are nine tracks at one end, expanding to 13 tracks at the other, we may judge that it is among the widest bridges of its size and type ever built. The deck arrangement, of course, is very convenient under the circumstances, permitting any desired arrangement or changing of tracks and crossings. The floor is solid, the ballast being laid on concrete, resting on a course of asphaltic concrete placed over trough floor-plating.

Fig. 1. Beginning Span, with Top-Chord Splice Connections.

Fig. 2. Near Junction, with Two Sets of Diagonal Hangers.

FIGS. 1 AND 2. CANTILEVER ERECTION OF CHANNEL SPAN, WEAR RIVER BRIDGE, AT SUNDERLAND, ENGLAND.

(Span about 350 ft. c. to c.; 330 ft. clear. Double deck. Upper deck, two railway tracks; lower deck, roadway between trusses, footwalks outside. Weight of steelwork of span, 16,500 lbs. per lin. ft.)

The special advantage of erection of both truss and caisson work on the staging was that it permitted the work on the superstructure to go on without waiting for the piers, and, in fact, several of the trusses were completed by the time the piers were ready for them. The trusses were all erected a few feet above their final position, and as each was completed it was lowered to the bridge seats on the piers. The engineer for the bridge was Mr. D. A. Matheson.

Mr. Biggart makes the interesting comment that, while hydraulic riveting, which was extensively used on this bridge, is considered preferable in all cases, they had very good success with riveting by pneumatic tools, presumably tools of the hammer type:

> In the top booms thousands of rivets of a length of 9 ins. were thoroughly well closed by pneumatic tools without difficulty. One of the essential conditions to ensure sound riveting, and especially pneumatic riveting, is that the work should be thoroughly bolted up in advance.

Bridge Over Barrow River, Ireland; Deep Cylinder Pier Foundations.

A long single-track railway bridge over the Barrow River, in Southern Ireland, is remarkable for the depth of its foundations, these being formed directly by the cylinders which form the piers. The cylinders were sunk by the pneumatic process. The bridge is 2,131 ft. long and comprises 13 140-ft. fixed spans (148 ft. c. to c. piers) and a 214-ft. swing span. The latter is interesting because it is of pure rim-bearing type, as is also the swing span of the Nile River Bridge, mentioned farther on. The fixed spans are of through arrangement, with Pratt trusses 20 ft. deep spaced 16½ ft. apart.

A further exceptional feature of this structure is that the latches of the swing-span are interlocked with railway signals on either side of the crossing, this interlocking extending 3 mi. on one side and no less than 5¼ mi. on the other side. Whenever a train is approaching the bridge within these distances, the draw is locked in the closed position, and when the bridge is open the signals in the same sections are locked at danger.

The piers consist each of two cylinders 8 ft. in diameter, with base spread to a diameter of 10 to 15 ft. These are spaced 26 ft. c. to c. transverse to the bridge. At the top the pair of cylinders is connected by a top strut or cap girder below which are several panels of diagonals. The cylinders are of steel from the base up to the river bed and of cast-iron rings above this. In all cases the top ring is of an odd length as determined by the depth at which the caisson was stopped.

The deepest of the set went down over 100 ft. below low water, or nearly 120 ft. below high water. The greatest air pressure, however, was only 45 lbs., and special care was taken to avoid the need of a higher pressure. To this end pneumatic ejectors were employed to blow out the water seeping in at the bottom.

The results attained were such that it was possible to carry out work at depths which otherwise it is not probable could have been done by the pneumatic process. This high pressure constituted the chief difficulty encountered in the work, and special precautions had to be taken to minimize cases of illness amongst the workmen. These consisted largely in reducing the length of each shift, enforcing slow passage when coming out of the air locks, providing warm refreshments, and insisting on the workmen, at all times, taking sufficient rest immediately they came out of the locks.

Mr. Biggart credits these with being the deepest pneumatic piers in the country. The soil through which they were sunk is mainly sand, with a small depth of clay just overlying the rock on which they were founded. The trusses of this bridge were erected on a full-width erection staging, as in the case of the Clyde Bridge. This falsework had a wider part at each pier, where the cylinders were built and lowered to the river bed to start the sinking.

Sir B. Baker was engineer for the bridge. The swing-span is operated by an electric motor fed by storage batteries. An oil-engine dynamo located on the fender pier charges these batteries, which have capacity for a week's service.

The Suir Viaduct: Bursting of a Cast-Iron Pier Ring.

A bridge very similar to that over the Barrow, and only eight miles away, is notable for having as its draw a hand-operated Scherzer rolling-lift bascule, and, further, for a rather remarkable accident which occurred during the pier sinking.

The bridge is 1,205 ft. long between abutments, and consists of eight fixed spans, mostly 140 ft. long in the clear, and a Scherzer lift span giving a 50-ft. clear opening. The fixed spans are parallel-chord through Pratt trusses. The lift span is a plate girder, and its track girders are supported partly by the grillages on the top of the pier and partly by an extension of the adjoining

truss. It is operated by hand only. The author states that it can be opened in 3¼ mins. and closed in 2½ mins., including all the necessary piers.

The piers are cylinder piers, like those of the Barrow Bridge, but of less depth. The subsoil is mud, peat, clay, and sand and gravel. They were sunk by compressed air, and this led to an accident in the case of one of them. When this cylinder was nearly down to full depth (70 ft. special attention had to be given to esthetic effect, and designs were therefore chosen which combined graceful appearance with structurally correct form and also admitted of effective architectural treatment in the parapets and masonry abutment.

This doubtless is the reason for the adoption of the several structural peculiarities above noted.

The piers are steel cylinder piers, each composed of two cylinders 10½ ft. in diameter in the shaft and 18 ft. at the base, spaced 47½ ft. on centers transversely. The foundation level in all cases is 92 ft. below high water. The transverse connection between the two cylinders of each pier is a cap girder 7½ ft. deep and 4 ft. wide, which not only forms the bracing of the pier, but also carries the trusses. The cylinders are of steel up 12 ft. below the river bed, and above this are of cast iron 1¼ ins. thick. They were built on the bridge falsework and lowered, just as in the case of the bridges above described, and most of them were sunk with the use of compressed air; a maximum pressure of 35 lbs. was reached. Arab labor, with European supervision, was largely employed.

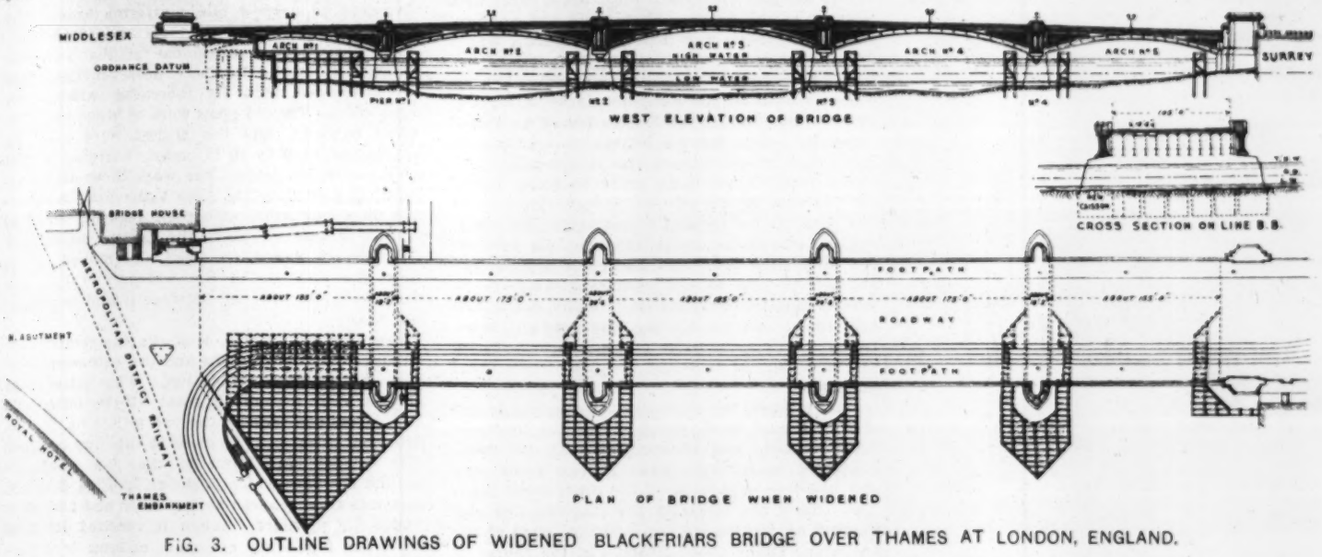


FIG. 3. OUTLINE DRAWINGS OF WIDENED BLACKFRIARS BRIDGE OVER THAMES AT LONDON, ENGLAND.

below river bottom), one of the cast-iron rings forming the upper part of the cylinder burst, killing one man. The air pressure at the time was 32 lbs. per sq. in., giving a tensile stress in the metal of only about 1,230 lbs. per sq. in. No flaw could be detected on the fracture surfaces, and the test-pieces from the broken ring gave satisfactory results. The author therefore remarks:

> The cause of the failure remains unknown, and can only be regarded as another proof of the unreliability of cast-iron as a constructive material. While its suitability has been satisfactorily demonstrated for many purposes, its use carries with it risks which it is well to take into account where life may be endangered.

To repair the damage a cofferdam was driven around the cylinder, the broken shaft rebuilt, an internal steel shaft 3 ft. in diameter inserted from the concrete up, and the space between the steel rings and the concrete of the pier shaft was grouted for a length of 9 ft. to seal the joint. The air-lock was placed on the inner shaft, so that the remaining pneumatic work could be continued without subjecting the cast-iron to the air pressure.

Sir Benjamin Baker was engineer for the bridge. This, as well as the Barrow Bridge, carries a line of the Irish standard gage of 5 ft. 3 ins.

Cantilever Bridge Over the Nile at Cairo.

A bridge designed as well as built by the Arrol firm crosses the main branch of the Nile between Ghizeh and Rodah Island, in Egypt. It is peculiar in consisting of a succession of cantilever spans. Its total length is 1,755 ft., comprising ten 140-ft. spans; two 70-ft. spans and a 220-ft. swing span. The roadway width is 66 ft., and on it are two lines of meter-gage street railway, both located on one side of the roadway, which led to an unsymmetrical spacing of the five trusses. The floor is of asphalt and concrete on buckle-plates, while the footwalks (cantilevered out) are 1 in. of asphalt on flat steel plates.

The trusses of the fixed spans are of peculiar shape, the bottom chord being curved upward so as to give a less depth at the center than at the ends. They are continuous over the piers, but in alternate spans are cut at the points of contraflexure so that the whole structure is a succession of cantilevers. The structure is of the deck type, although the high flood stages require such a clearance as to limit the depth of the trusses under these conditions so that they are unusually shallow. Mr. Biggart states that in the design working from both ends. To minimize the erection stresses, diagonal hangers were employed to support the cantilever halves until joined at the center, the hangers being attached to temporary steel towers built over the piers, anchored by backstays to the rear end of the adjoining span.

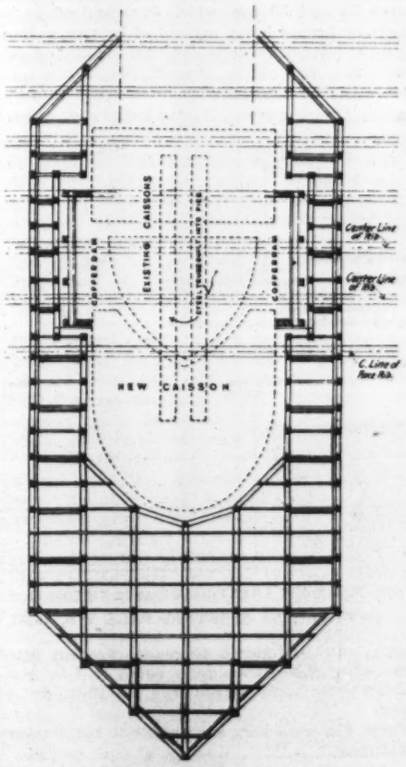


Fig. 4. Part Plan at a River Pier of Blackfriars Bridge, Showing Working Platform and Location of New Caisson.

Wear River Bridge: Erection by the Cantilever Method.

The North-Eastern Ry. Co. crosses the River Wear at Sunderland on a very heavy double-deck combined highway and double-track railway bridge. The central span, which is about 330 ft. long c. to c., was erected by the cantilever method.

The bridge comprises three spans 200 ft. in the clear (224 ft. long over all), one channel span of 330 ft. in the clear (354 ft. over all), and viaduct approaches. The 350-ft. span lies between two of the 220-ft. spans. The piers are of granite, most of them founded in cofferdams, but one founded on a 65 × 35-ft. steel caisson sunk by compressed air to rock 75 ft. below high water. The superstructure consists of two trusses 32 ft. apart, with a double web system. There are two decks, the upper carrying the two railway tracks. The lower or roadway floor is hung just below the bottom chords by hangers, and its floor beams project 14 ft. on either side to carry the footways, gas pipes, etc.

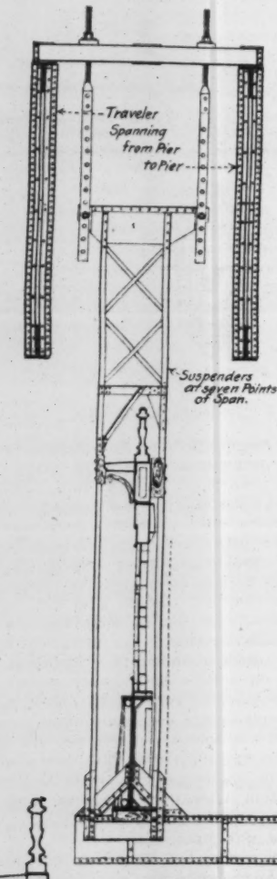
The trusses of the 350-ft. channel span are 30 ft. deep at the ends, and 42 ft. deep at the center. The weight of steelwork in this span is stated at 2,600 English tons (2,900 tons), which is over 16,000 lbs. per lin. ft. Before its erection was begun, all the other spans had been erected on falsework in place. For the channel span, however, falsework was not permissible on account of heavy river traffic, which also, in connection with the weight of the span and its height above water (85 ft.), prohibited its being floated into place. The cantilever method was therefore used.

To begin with, the first bottom-chord sections of the channel span were set in place, held temporarily by diagonal hangers from the anchorage span. Then the end posts were set, bolted to the anchorage span at the top and separated from it by wedges at the bottom for adjusting to exact position and alinement. The diagonals, posts at first panel-point and end sections of top chord were then placed, in order, and the panel riveted up. The ends of the bottom chords of both channel and anchorage span had been faced off before erection, and between these faced surfaces solid steel thrust blocks were now placed, and these transmitted the bottom-chord compression throughout the erection period. The top chords, as soon as set, were anchored back to the finished span by riveted tie plates on sides and top, but these were in service only for a short time.

Erection of the trusses then proceeded, and at the same time the transverse floor beams were

set and riveted, and during the first part of the erection also the stringers and floor plating were put in, to give lateral stiffness. Fig. 1 herewith shows the erection during this stage.

Meanwhile a heavy steel A-frame was built on either pier, to a height of about 70 ft., and from its top a long plate tie in the plane of each truss was run back to an attachment at the far end of the anchorage span as a backstay. Similar ties were run forward to meet the bottom chord of the cantilever work at a point about 80 ft. from the pier. As soon as the erection reached this point, the ties or hangers were connected to special hitch-plates attached to the chords at this point.



The hangers had a gap at mid-length, and here hydraulic jacks were inserted to draw up the ties so that they carried the weight of the overhang, hitherto borne by the tension splice of the end of the top chord. The top-chord splice being thus relieved was removed, and then the ties were drawn up again, an amount sufficient to lift the end of the overhanging work about 3 ins. more, this being an allowance for the deflection due to the remainder of the erection. The ties were now bolted up and the hydraulic jacks removed, and erection went forward.

In just the same way, a second set of ties was attached to the bottom chord 50 ft. farther out, or about 130 ft. from the pier. The second hanger was drawn up with just enough tension to take all stress out of the first set, though the latter was not cut or removed. Erection was again carried forward and no further difficulty occurred except making a precise adjustment of length for the junction at the center. The view Fig. 2 shows the bridge shortly before junction, with both sets of hangers in place.

The junction sections of the chords were not cut to length or drilled until the work was ready for them and measurements had been taken across the gap by wooden rods, which were then shipped to the works. Each plate and angle of the chord section was then cut to correct length and the splice holes drilled, and the parts assembled as erected. Connection was made at one end only until all closure members were in place, and the remaining splices were bolted up simultaneously. This closure bolting took only one-half hour. No adjustment was required, but provision therefor had been made as follows: At the far end of the two anchorage spans jacks had been set for vertical adjustment. For longitudinal adjustment jacks had been set between one anchorage span and the span beyond, enabling one side of the cantilever work to be pushed ahead longitudinally. Finally, for lateral adjustment diagonal bracing rods were put in between the opposite parts of the cantilever work at the center, to draw the two halves into exact alinement.

After closure, the expansion bearing at one end of the channel span, which up to this time had been blocked, was released so that the three connected spans were fixed at one point only and had free expansion at the other three bearings. Then the stress in the diagonal ties was relieved by jacking up the landward ends of the anchorage spans about 10 ins. In the course of this procedure, the river span deflected 2⅝ ins. before the ties were completely slacked off. The ties were disconnected and lastly the rear ends of the anchorage spans were again lowered to bearing.

The diagonal ties, formed of groups of flat plates 24 and 30 ins. wide, were spliced at all points by turned bolts, instead of by rivets. Bolts were used for convenience in connecting and disconnecting, but before proportioning them tests were made to determine their shearing value as compared with rivets. It was found that turned steel bolts 1 1-16 ins. in diameter, carefully fitted into drilled holes, were fully equal to 1-in. steel rivets hydraulically driven into 1 1-16-in. drilled holes.

These ties were very susceptible to temperature variations.

The effect of the weather conditions upon the large exposed surface of the supporting ties was readily apparent in the rise and fall of the overhanging portion of the span. During the spell of warm weather in September, the point of the span moved transversely a maximum distance of 1⅝ ins.

Many of the truss members required strengthening for the erection stresses, and the author notes particularly that several of the main diagonals, consisting of flat plates, had to be converted into compression members temporarily by the addition of angle and lattice bracing. M... A. Harrison was engineer for the work.

Widening Blackfriars Bridge in Lond...

An unusual operation was the widenin... Blackfriars Bridge across the Thames at Lo... from 43 ft. to 73 ft. roadway width, espec... unusual because the bridge is a series of ... rib arches. The operation was conducted ... successfully, however, and with little inter... ence to traffic. The falsework in the river ... restricted to narrow pile platforms around ... several piers.

The structural arrangement of the bridge is shown fully by Fig. 3, where, however, the bridge is represented with its increased width after completion. The old piers were of stone on pneumatic caissons, and the arches were steel rib arches spaced 9 to 10 ft. apart, carrying a floor of pavement on plate. The work to be done consisted of extending the piers upstream, and placing three new ribs, with their flooring, etc. As it was desired to retain the facade unchanged, the face rib was diconnected and moved out to form the face rib of the widened bridge, and three new ribs were set between it and the existing ribs.

The plan sketch, Fig. 4, shows the relative positions of the old caissons and the extension caisson of one pier foundation. The latter was shaped with a rounded point at the outer end and a recessed face on the end adjoining the old caissons, so as to fit as close to them as possible. The caisson was built on the pile platforms around the pier, which is shown in Figs. 3 and 4, and was then lowered to the river bed and sunk under air pressure. When it reached its final level, the temporary enclosure caisson or cofferdam above the foundation caisson was sealed against the old pier by a wooden cofferdam (see Fig. 4) so that the stonework carried up could be bonded to the old stonework thoroughly. Below the stonework the space of some 12 ins. between the old and new caissons was cleaned out and filled with concrete.

The pier foundation work was completed without trouble, it appears, except that one of the caissons fell from its jacks when being lowered and caused some delay and expense to recover it and repair the damage.

More difficult foundation work had to be done at the north abutment, where the Metropolitan District Ry. tunnel close by and the seawall of the Thames Embankment complicated things. The extension of the abutment, long and narrow in plan, was founded on three separate caissons, to minimize risk by subdividing the operations. For further protection, *cast-iron sheet piling* was driven behind the site of the abutment close to the District Ry. Tunnel and to a depth below the abutment foundation. When the three caissons were completed and filled with concrete, they were loaded with rails to a base pressure exceeding that which would occur under load, and the load was left in place for seven days, both to test the foundation and to forestall the ill effects of having the initial settlement occur after the erection of the abutment masonry and arches.

A peculiar feature of this abutment is that, being restricted to a narrower width than desirable for stability, its masonry consists in part of cast-iron blocks in place of stone to increase its weight and therefore its stability against overturning. Further, a girder was set under the new skewbacks to distribute the arch thrust over the whole length of the wall uniformly. A cantilever girder had also to be built into this abut-

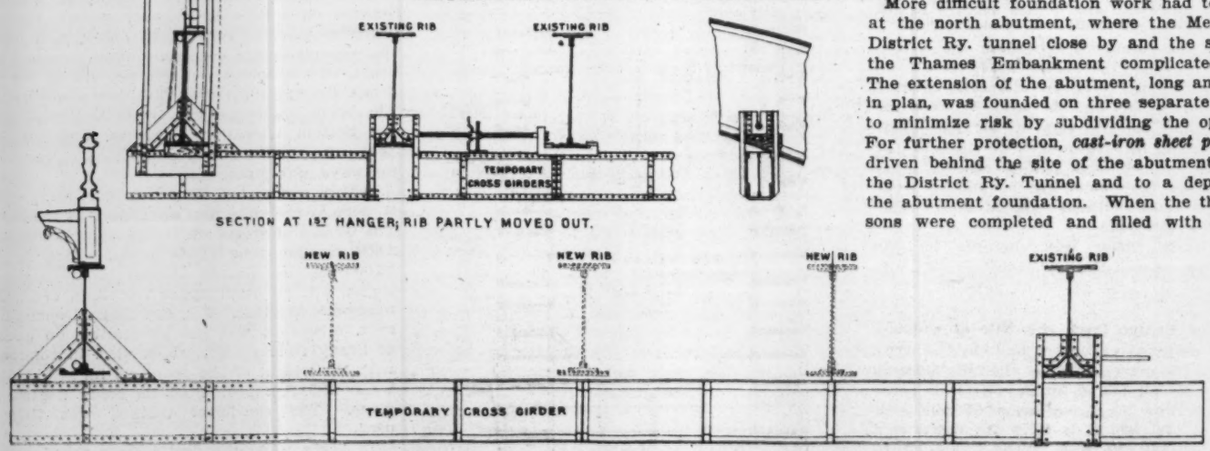


FIG. 5. TRANSFER GANTRY FOR SHIFTING FACE RIB, BLACKFRIARS BRIDGE.

ment to carry the floor of a short-radius curved approach to the bridge.

The superstructure work was handled by the method shown by Fig. 5. A two-truss gantry frame was built, spanning between adjacent piers and running on tracks laid transverse to the bridge on the tops of the pier extensions. Hangers were fastened to this traveler for picking up the face rib, to enable the traveler to carry it out to its new position.

A working platform for the erection of the new intermediate ribs was obtained by hanging cross

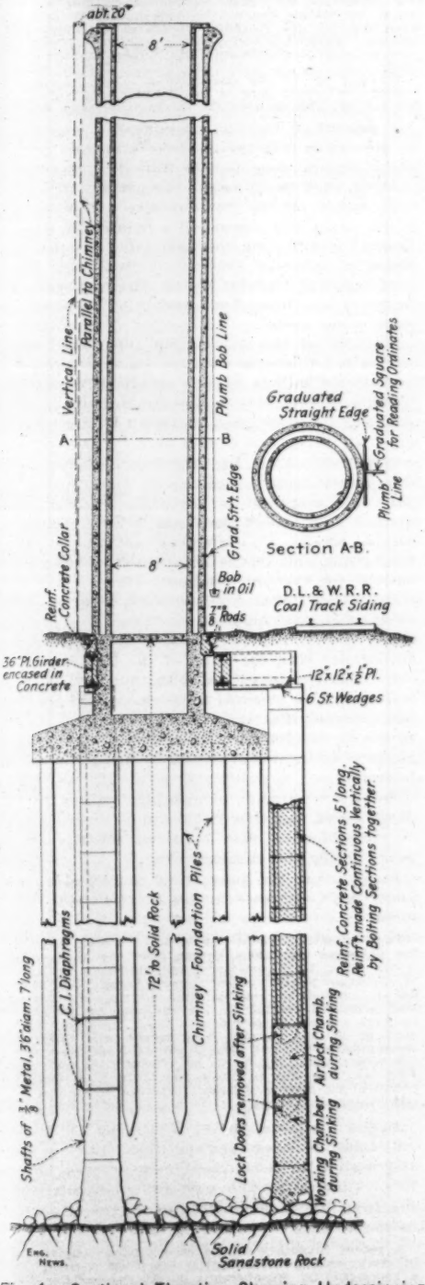


Fig. 1. Sectional Elevation Showing Underpinning of Concrete Chimney, Jersey City, N. J.

girders from the face rib and the adjoining old rib, spanning the entire 40-ft. space occupied by the new ribs. These girders were attached to the face rib before it was moved, and had a sliding support under the fixed arches. By a horizontal screw connecting the girders with the fixed work the outward movement of the face rib and traveler could be controlled. The cross section in Fig. 5 shows clearly how these cross girders were utilized as supports for the new ribs. The erection of the new ribs thereafter was a matter of no difficulty.

It only remains to add that the operations of shifting the face rib and erecting the intermediate ribs were so arranged in the successive spans (five spans 155 to 185 ft. in the clear) as to minimize the unbalanced thrust on the new sections of pier.

The engineers for the Blackfriars Bridge work were Sir B. Baker and Mr. Basil Mott.

Underpinning a Leaning Chimney with Concrete Caissons.

By OGDEN MERRILL,* Assoc. M. Am. Soc. C. E.

Nine years ago, the Central Lard Co. (now Halstead & Co.) built, as a part of a new plant located at 17th and Coles Sts., in Jersey City, N. J., a reinforced-concrete chimney 108 ft. high above the foundations. As shown in Fig. 1, the chimney is founded on piles. Shortly after the chimney was built it began to lean toward the northwest, the piles on that side evidently settling under the weight of the stack, aided later by the fact that the nearby coal track for the plant was in use with 100,000-lb. capacity coal cars delivering coal to the plant, the fill under this track and that over the base plinth of the chimney being one continuous mass of loose cinders. This leaning continued until the steel flue began to pull the brick wall of the boiler house out of line.

The chimney is out of plumb about 1 ft. 8 ins. in the 100-ft. length above the ground. While this condition was not considered immediately dangerous, it was decided to watch it closely in order to determine accurately its further movement, if any, and for this purpose a scheme, suggested by the writer (at that time Consulting Engineer for the Halstead company) and shown in Figs. 1 and 2, was adopted and put into use about a year ago. A plumb-bob line was fastened approximately on the side of the greatest lean, about half way up the chimney and the plumb-bob hanging therefrom suspended in a pail of oil. A horizontal graduated straight edge was attached to the chimney at right angles to the plumb line and tangent at the same element of the cylinder as the plumb-bob. Ordinates read by means of a graduated square enabled calculations to be made as to the amount of lean in the directions parallel and at right angles to the straight edge. The plumb-bob wire is protected from the wind by means of a 6-in. spirally wound sheet steel pipe, and the straight edge and bob are protected inside a small house fastened to the chimney. This arrangement was placed on the chimney early in 1908, and daily readings have since been recorded by Mr. Theodore E. Smith, the Technical Manager of the company. These readings showed slight changes in the position of the top of the chimney; and fearing that the chimney might take a greater lean to the danger point, and that continual swaying with a slight increment would bring it to the danger point and require its removal and reconstruction, it was decided to underpin it and make certain its safety.

This underpinning has recently been completed by the Merrill-Ruckgaber Co., by the methods shown in Figs. 1 and 2. Pneumatic caissons in locations shown in Fig. 2 were sunk, as shown in Fig. 1, and were filled with concrete from the rock up to the top. The tops of the caissons support a system of three plate-girder beams, which are also encased in concrete. An excellent bond was made with the chimney by removing a little concrete at tangent points of these beams, thus allowing one-half width (6 ins.) of the beams to set into the chimney. The vertical reinforcing bars cut by this removal were bent out and around the beams as well. For 2 ft. above the top of the girder elevation, a bond was also made with the chimney, all the way around, and a reinforced-concrete collar was placed to take the load from the chimney to these tangent points. These girders were designed for

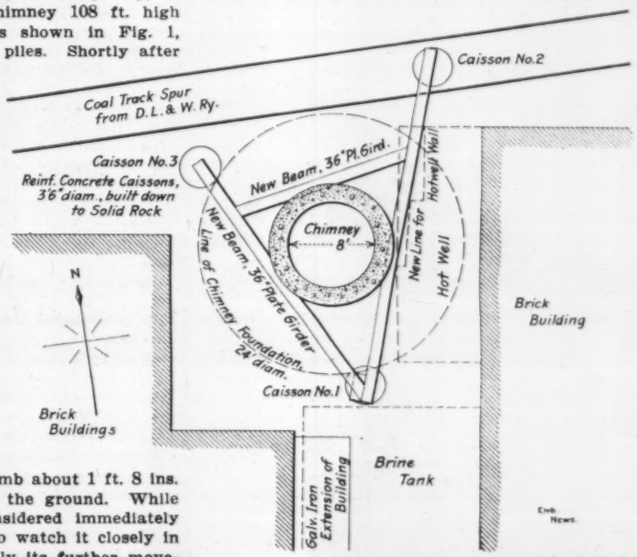


FIG. 2. PLAN OF UNDERPINNING OPERATIONS.

any condition of wind pressure and dead load and were designed to take all of the load above the base plinth; the piling and the bearing on the soil under this plinth were regarded as sufficient to take its load.

CONSTRUCTION.—The methods used for construction of these caissons were devised by the contractor with special reference to the job in hand. The loads are such that very small concrete columns from the rock up would be sufficient. A section 3 ft. 6 ins. diameter was chosen as the most economical. The caissons were sunk by use of pneumatic pressure. The lock was placed at the bottom just above the working chamber. Fig. 3 shows a group of the sections of the shaft used above the lock. A scheme for fastening consecutive sections together is provided by means of circumferential rings of 3 × ⅜-in. steel bars with matched open holes for quick bolting together. The rings at the ends of each section are held together by six ⅞-in. diameter steel rods countersunk at each end into these 3 × ⅜-in. bar rings. Additional circumferential reinforcement was provided by spirally winding

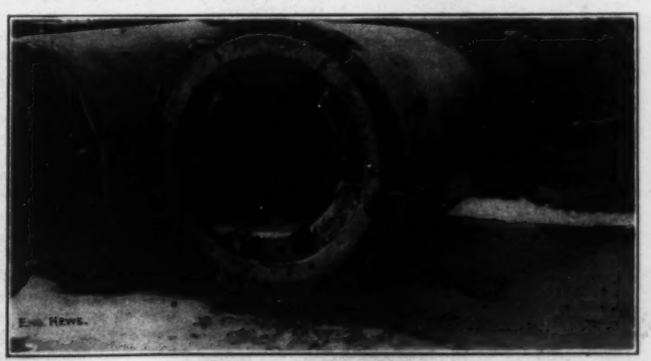


FIG. 3 VIEW OF REINFORCED-CONCRETE CAISSON SECTIONS USED IN UNDERPINNING A LEANING CHIMNEY.

*President, Merrill-Ruckgaber Co., Contracting Engineers, 50 Church St., New York City, N. Y.

this cage of ⅞-in. rods with ¼-in. steel wire, the distance between winds of the spiral being 6 ins. The offset along the 3 × ⅜-in. bar from the open holes shown to the countersunk steel rods was only 2½ ins., so that, when the rings were bolted together with ⅞-in. bolts through the open holes shown, the vertical reinforcement was practically continuous and the circumferential bars, together with the spiral winding, made very strong circumferential reinforcement. As these sections of shaft were made, and the concrete thoroughly set, before being placed in the work, they were put rapidly into position without delays as the work progressed.

The lower portion of about 7 ft. in each caisson was excavated below the cutting edge, some of the large boulders in this portion of the excavation being left in place for a part of the concrete filling.

After the caissons were sunk and filled, and the beams placed in position, the reinforced-concrete collar was constructed and the beams were encased in concrete as shown in Fig. 1, leaving the end of the beam on caisson No. 3 exposed. After the concrete had had a two weeks set, steel wedges were driven between the bottom of the girder and the top of the caisson column, throwing a load into the girders and actually taking a fraction of an inch of the lean out of the chimney. These wedges and the end of this girder were then encased in concrete, the ¾-in. cable guys, which for safeguard had been fastened from the top of the chimney back to the south and east before work on the foundation had commenced, were removed and the surface of the ground around the chimney was restored to its level.

Annual Convention of the Master Car Builders' Association.

Following the convention of the American Railway Master Mechanics' Association, noted in our columns last week, the 43d annual convention of the Master Car Builders' Association was held at Atlantic City, N. J., June 21-23, 1909. The cool and pleasant weather of the previous week was succeeded by a decidedly hot wave which made the deliberations of the convention rather unpleasant, although the exposed position of the exhibition on the pier made that portion of the week's work most comfortable and justified the return of the convention to a place where so admirable a location for the exhibit could be had.

As in the related society, the absorption of the Master Car Builders' Association by the American Railway Association did not transpire as expected at last year's convention. In the revised constitution adopted, reference to which will be made hereinafter, the only reference to the superior organization is the following:

Subjects involving legal, transportation, permanent way or traffic questions, or for any other reason requiring such action, may be submitted as recommendations to the American Railway Association.

The question of the consolidation of the two railway mechanical societies did not receive the encouragement from the Master Car Builders that it did from the Master Mechanics. Although a committee was appointed to confer with a committee from the other association regarding this combination, the general feeling of the members seemed to be well expressed in the following portion of the president's address:

For years the question of consolidating the Master Car Builders' and the American Railway Master Mechanics' Associations has been the subject of discussion. Such action has heretofore not been deemed either necessary or desirable, and conditions at present do not indicate that it would now result in any benefit to railway companies. Unless improvement is possible, changes should not be favored. The two associations are separate and distinct so far as their line of action is concerned. The Master Mechanics' is of a technical character, having no legislative powers, and as the Master Car Builders' find it impossible to devote sufficient time to the proper consideration of the various reports submitted to them, the proposed consolidation seems unwise, especially as new topics, new subjects and new discussions would be introduced into our deliberations. There is sufficient work for each association in its own particular field, and as the method of procedure is handling work incident to locomotive repairs and construction, car repairs, construction and interchange, differs so very materially, it would seem desirable to handle them as two separate and distinct branches, so that the questions incident to each will be considered by two separate and distinct associations.

It was reported that the membership of the Association had increased from 727 in 1908 to 769 in 1909, and the cars represented from 2,-283,330 to 2,403,961 in the same years. Financially the society is flourishing. A bequest of $5,000 from the late Emma A. Tillotson, widow of Luther G. Tillotson, was accepted, the interest on the fund to be devoted to experimental investigations.

PRESIDENT'S ADDRESS.—In addition to the above opinion on the consolidation of the two railway mechanical societies the address of the President, Mr. R. F. McKenna (Master Car Builder, D., L. & W. R. R.), urged the thoughtful considerations of the questions of car wheels, disposal of salt-water drippings from cars, standard couplers, the electrification of railways and lumber specifications All of these subjects are to be before special or standing committees during the coming year.

STANDARDS.—The most important function of the Association is the fixing of standards of car construction which are adopted by the subscribing roads and the arbitration of disputes on car interchange and repair. These two duties, however, are performed mostly by committees and occupy little of the time of the convention. Certain detailed changes in construction were adopted (to be finally decided by letter ballot) and the decisions of the arbitration committee approved. It was also reported that the M. C. B. standards had been adopted as law on the Isthmus of Panama and that it is probable that in the near future action will be taken to make similar federal and state laws.

REVISION OF THE CONSTITUTION.—The revised constitution sent to letter ballot this meeting provides a much smoother working organization than the old. More power is put in the hands of the executive committee, as has been shown to be necessary in the past, but the election of that committee is more formal than heretofore. The second important change is the provision that all members, whether active, representative or associate (that is engineers not actively engaged in the car or motive departments of railways), shall be compelled to relinquish their membership at any time their qualifications for such membership expire. There have been a number of cases where members have left active railway service to go into commercial lines and have retained the membership, which gave them a certain advantage over their competitors. This practice, it is hoped, will be stopped by the new constitution. The third important change refers to the American Railway Association as noted above.

Committee Reports.

Unless otherwise stated the reports herein noted were passed to letter ballot for approval of the Association.

TRAIN BRAKE AND SIGNAL EQUIPMENT.—This is the present name of the former committee on Air Brake Tests, which has now been enlarged to take in the entire subject of air brake and signal equipment of cars for both automatic and foundation brakes. The report this year submitted a design of a standard brake shaft and fittings. This was passed to letter ballot to be adopted as "Recommended Practice." The committee also reported that the expected triple-valve tests at the new 100-car triple-valve test rack at Purdue University had not as yet been carried out because of the inability of manufacturers to furnish the valves. The rack is ready and the tests will be made in the near future and reported next year.

PAINTING STEEL CARS.—This committee gave results of time tests on preservative coatings on a number of cars, which results we publish separately in this issue. In addition it renews the following recommendations:

We are of the opinion that suitable buildings should be provided for the painting of cars, so that the painting of the equipment would not necessarily be confined to certain seasons of the year, for it is essential that equipment, regardless of the season, be well covered with a protective coating, in order to arrest deterioration, which otherwise is very rapid.

In the preparation of the assembled parts of new cars they should not be exposed to the weather or permitted to rust before their assemblage.

In all cases where metal is placed against metal, either riveted or bolted, it should be free from flash or rust and covered with one or two coats of red lead, and the mixture be heavy enough to exclude moi... but this protection will avail little unless extra ca... taken that all the steel parts fit evenly and are a... in like manner.

After cars are ready for the first coating it is n... sary that all flash and rust be removed. This sh... be done under rigid inspection. Unless the flash i... moved it will invariably fall off inside of one year... continue as long as any remains, regardless of... number of coats of paint applied. We recommend... flash and rust be removed by sand blast, where pos... We would next recommend dry cleaning (which we... not believe so satisfactory), by using steel scr... brushes, sand stone or any tools which will answer... purpose, being particular to remove all the dust w... suitable brushes or dusters. After following either... these cleanings we suggest the application of three co... of paint at 24-hr. intervals. In the preparation of ... for repainting we again recommend cleaning by ... blast, but if this can not be done under all conditi... then use the dry cleaning process as previously m... tioned. After the dry cleaning we would recomme... two coats of your standard paint applied at 24-hr. inter... vals.

We can not be too emphatic as to the necessity of taking the proper care of the exterior, and regret that we are not able to give the interior the same care.

In regard to the last paragraph it was stated in discussion that the inside of steel cars in constant service does not need much preservative coating, that the constant movement of the coal, etc., wears off the rust or dirt and keeps the metal clean and sound. Six months of idleness is more wearing on the inside of a car than five years of constant service. It was also stated that repeated cleaning of the rust and scale preparatory to repainting materially reduces the gage of the metal.

By vote of the Association the Committee is authorized to confer with the Committee on Preservative Coatings of the American Society for Testing Materials and like committees of other societies in order that the work of the various associations on this matter may be coordinated.

COUPLER AND DRAFT EQUIPMENT.—This Committee made a number of tests during the year on couplers in order to discover some method that would give test breaks similar to service breaks. A satisfactory method was finally discovered, and this is substituted in the specifications for the one originally there. It is also recommended that knuckle-pivot pins be tested along with the couplers, as these pins are frequent sources of breaks in coupler equipment. In accordance with the order of the last convention the Committee investigated the question of chemical as well as physical requirements for couplers, but reported that it is not fair to the manufacturers to require both tests, and of the two the physical is the most certain to bring desired results.

Studies were made of existing tests on friction draft gears, but they could not be utilized, so it is recommended that tests on these gears be made during the ensuing year.

In regard to the question of coupler side clearance, the Committee makes the following statement:

Your committee would like to make special mention of the following deductions, drawn from the results of the tests: First, train resistance, and, therefore, the amount of tonnage hauled under general road conditions is not influenced by coupler side clearance; second, the side pressures exerted on the end sills of cars by the couplers are not excessive with 2½-in. clearance on any road or on any normal yard curves, and third, it is recommended that the present standard side clearance of "Not less than 2½ ins.," be changed to read simply "2½ ins.," as this is ample and there is a liability of couplers not mating if more clearance is allowed without centering devices.

In the discussion Mr. F. W. Brazier (N. Y. Central Line) declared that the time had come when the design of a standard coupler was imperative. Illustrating the wasteful conditions resulting from the great variety of makes of couplers in use he gave the following figures:

A recent inventory of the second-hand coupler bodies in stock waiting repair parts, taken on a road having a representative membership in the Master Car Builders' Association of 72,000 cars, showed a stock of 2,015 coupler bodies. This was divided between 25 different makes of couplers and represented in the credit allowed car owners therefor at 75% of new value, the sum of $11,707. To be conservative, we might eliminate 719 coupler bodies, representing a value of $3,737, which covers four types of couplers that could be classed as standards for that road. This leaves 1,296 coupler bodies, valued at $7,969, that are being held for some repair parts to make the coupler complete.

On a car representative basis this means $0.11 per car for that road, and with a representation in the Master Car Builders' Association of 2,292,790 cars this would mean a money value, assuming all roads in the association met with similar conditions (and this is a fair assumption) of $252,207.

This same road at present carries a stock of coupler material valued at $27,744, of types standard to its cars, which is $0.38 per car. Its stock of coupler material, types standard to its equipment, foreign incomplete

couplers, and foreign coupler repair parts included, is valued at $43,122, or $0.60 per car. On the total representation in the association, this would mean that these roads are carrying coupler material valued at $1,375,679; whereas they could, with a standard coupler, reduce this to $871,263. This would effect a saving of $504,415 or 37%.

SIDE BEARINGS AND CENTER PLATES.—No tests on this matter have been made during the past year, but detailed arrangements have been made with a number of roads to undertake tests during the coming year to determine

1. The resistance to turning of different types of center plates. 2. The effect of lubricating center plates. 3. The resistance to turning of different types of side bearings. 4. The effect of varying the clearance of side bearings with a view to determining the best clearance. 5. The effect of varying the spread of side bearings with a view to determining the best spread.

BRAKE-SHOE TESTS.—During the past year this committee has had built a very delicate weighing machine which is capable of detecting differences of 0.002 lbs. in the weight of a car wheel and, with the aid of this, very definite results are expected during the coming year in determining the wear of the brake-shoe upon the wheel.

CAR WHEELS.—The report of this Committee was last year rejected and referred back for further consideration because of the opinion of one minority member, backed up by the convention, that a chemical specification should be given for all car wheels. This year the Committee, after seeking the cooperation and advice of a committee from the car wheel manufacturers, decided that the time is not yet ripe for the adoption of a chemical specification, though it is hoped that next year one can be submitted. The report this year is not very different from that of last year. It recommends certain changes in the present gages and methods of gaging, the substitution of a 625-lb. for the present 600-lb. and a 725-lb. for the present 700-lb. cast-iron wheel, and submits specifications for "33-in. cast-iron wheels for cars of 60,000, 80,000 and 100,000-lb. capacity."

A provision that all wheels must be marked with raised letters showing the name of the railroad for which they were made met with some opposition from those who thought that this would cause trouble when a road, not subscribing to the specification, should buy and put into service wheels rejected under the specification by the railroad whose name was stamped on the rims. The provision was passed, however.

In one of the discussions the question of responsibility for so-called "brake-burns" on tires was brought up. Brake-burn is the term applied to the surface cracking of the rim due to long-continued brake application. It is to be distinguished from "shelled-out" and "slid-flat" defects now recognized in the rules of the Association. A test made on heavily-loaded cars braked downgrade showed that cast-iron wheels of good material do not show this defect, which is doubtless due to an overheated tire. On the strength of such experiments and the experience of the members "brake-burn" was put into the rules as an owner's defect.

SALT-WATER DRIPPINGS FROM REFRIGERATOR CARS.—The maintenance-of-way departments of the railways have long objected to the manner in which the saline drippings from refrigerator cars are allowed to fall on the track, causing great damage thereto. This Committee recommends the placing of a tank inside the car to carry the melted ice and salt to certain stations, where it can be emptied outside the track. The main objection to this plan is the time lost in emptying, but it is thought that the benefit to the track is worth this loss. The Committee during the coming year intends to attempt a design of the car as suggested.

SPLICING SILLS.—Tests made by the Committee during the past year showed the great superiority of the butt-joint splice over the more frequently used scarfed splice with shoulders. Under the drop test the former showed 88% of the strength of the straight sill, while the latter showed only 23.5%. In accordance with these observations the Committee recommended the use of the butt-joint splice with side plates.

BOX CAR DOORS AND FIXTURES.—The report of this Committee, particularly that part which suggested temporary grain doors, was not satisfactory to the convention, so the Committee was continued and the report accepted, but not referred to letter ballot.

The Committees on "Tank Cars," "Freight Car Trucks" and "Safety Appliance" all submitted reports containing minor detailed changes in present rules or specifications. The reports were all accepted to be sent to letter ballot. The Committees on "Train Pipe and Connections for Steam Heat" and "Classes of Cars" reported progress and were continued.

Officers.

In continuation of the policy of electing officers from the higher mechanical officers of the railways the following ticket was elected for the year 1909-10: President, F. H. Clark, G. S. M. P., C., B. & Q. R. R.; 1st Vice-President, T. H. Curtis, S. M., L. & N. R. R.; 2d Vice-President, Le Grand Parish, S. M. P., L. S. & M. S. Ry.; 3d Vice-President, A. Stewart, G. S. M. P., Southern Ry. Mr. John Kirby and Mr. Jos. W. Taylor, 360 Old Colony Bldg., Chicago, Ill., were continued as Treasurer and Secretary, respectively.

Tests of a Double-Zone Bituminous Gas Producer.*

By JOHN B. KLUMPP,† Assoc. Am. Inst. E. E.; CARLTON A. GRAVES,‡ Assoc. Am. Inst. E. E., and IRVING E. MOULTROP,§ M. Am. Soc. M. E.

For a number of years extensive experimental work has been in progress at East Pittsburg [at the Westinghouse Machine Co.'s plant—Ed.], having for its object the development of a satisfactory producer suited to the use of various forms of bituminous fuels. During the same period, a design of non-bituminous producer in several different forms was developed, but without encountering the manifestly greater difficulties present in the successful gasification of bituminous fuels. A number of different types were available for the latter, which with sufficient attention could be operated with fair success, but in this case the builders adhered steadfastly to a definite standard. This standard involved a producer design capable of (1) continuous operation, (2) producing a gas free from tar, (3) operating at such temperatures as would avoid troublesome clinker formation, (4) producing a gas of normal constituents suited to high engine compression, and (5) finally, a producer that could be readily operated by a single attendant with comparatively little labor and skill. This latter qualification evidently necessitated a plant of the greatest simplicity.

The above-mentioned program of experiments on various types covered an exceedingly wide range in producer design and with full-sized models from 250 to 750 HP. tested for months at a time. These experiments included many forms of down-draft and under-feed systems, as well as various types of blowers and tar extractors, finally culminating in the present form of double-zone producer, which has proven entirely suitable for the ordinary bituminous fuels. This experimental work was recently concluded with a full year's continuous testing with various fuels and operating conditions, some tests lasting for a month, day and night, without shutting down. All of the results are based on the actual power developed as determined by brake tests of the gas engine.

These performance tests embraced both good and poor coals from the Pittsburg district and lignites from northern Colorado, Texas and South America, with a trial, also, of garbage, crude meadow peat and other waste material. The period of operation ranged from 10 to 24 hours a day throughout the month, generally at full or overload, and a two months' run was made to determine stand-by losses accurately. It is, therefore, believed that this series of tests constitutes an unusually complete demonstration of the ability of this type to operate continuously and satisfactorily with reasonable grades of bituminous fuels.

Description of Plant.

The general scheme will be observed from a sectional drawing (Fig. 1) showing a complete plant with all auxiliaries. An upper shell is superimposed upon a lower shell, with a cast-iron evaporator between. A hollow air-cooled top communicates with the evaporator through the downcomer and the uptake shown in the illustration. A second downcomer connects the evaporator with the lower tuyere. The producer is supported from four concrete foundation piers on a cast-iron mantle, the lower rim of which dips beneath the level of the water in the ash pit, forming a water seal.

In the normal operation of this producer, green fuel is fed through the open top and, during its descent to the offtake zone, is completely transformed into coke. During its further descent to the ash line this coke is completely gasified to ash. There are, therefore, two independent fuel beds, an upper and a lower one. In the former, tar vapors distilled from the fresh coal are transformed into fixed gas which mixes with the straight coke producer gas generated in the lower zone.

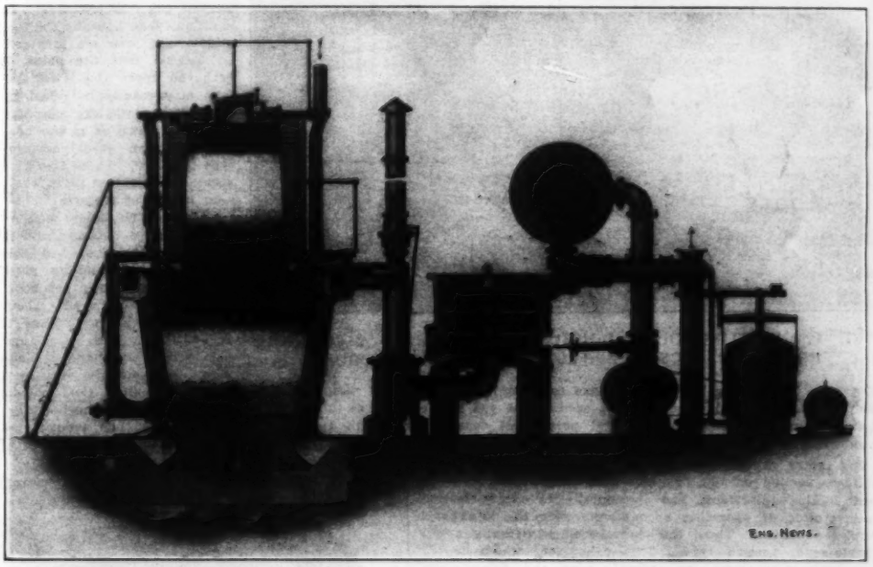


FIG. 1. SECTIONAL VIEW OF WESTINGHOUSE DOUBLE-ZONE BITUMINOUS GAS PRODUCER.

VAPORIZER.—It will be observed that there are also two combustion zones in this producer, one at the extreme top and one at the bottom just above the tuyere This is brought about by a double supply of vapor-laden air. This air supply is drawn in from above through the pipe seen projecting above the top of the producer at the right. Circulating entirely around the hollow top, it is heated to increase its capacity for taking up moisture and is then passed down over the surface of the water in the evaporator. This vaporizer is practically in contact with the hot fuel bed at the center of the producer, where it generates the water vapor necessary for cooling the fuel bed through dissociation, doing away with an external boiler to supply steam to the producer. Entering the vaporizer on the right, the heated air passes around to the opposite side where it divides, part ascending and part descending through the uptake and the downcomer, respectively. Valves are provided in these pipes to control the relative quantity of blast to the two combustion zones. This relation constitutes practically the only variable in the operation of the plant. It necessarily varies with different kinds of

*Abstracted from the "Report of Committee on Gas Engines," read before the National Electric Light Association at the convention in Atlantic City, N. J., June 1-4, 1909.

†Inspecting Engineer, United Gas Improvement Co., Philadelphia, Pa.
‡Edison Bldg., Pearl St., Brooklyn, N. Y.
§Mechanical Engineer, Edison Electric Illuminating Co. of Boston, 39 Boylston St., Boston, Mass.

fuels, but for any given fuel it should be necessary to regulate these valves only once. The automatic proportioning of vapor to air is otherwise provided for in the design of the producer, so that the process of gasification is automatic through the entire range of load.

With friable fuels, it is important to have the velocity of gas as low as possible at the offtake to prevent fine material being carried over. On this account the gas is drawn from the fuel bed at several points, all communicating with the annular offtake.

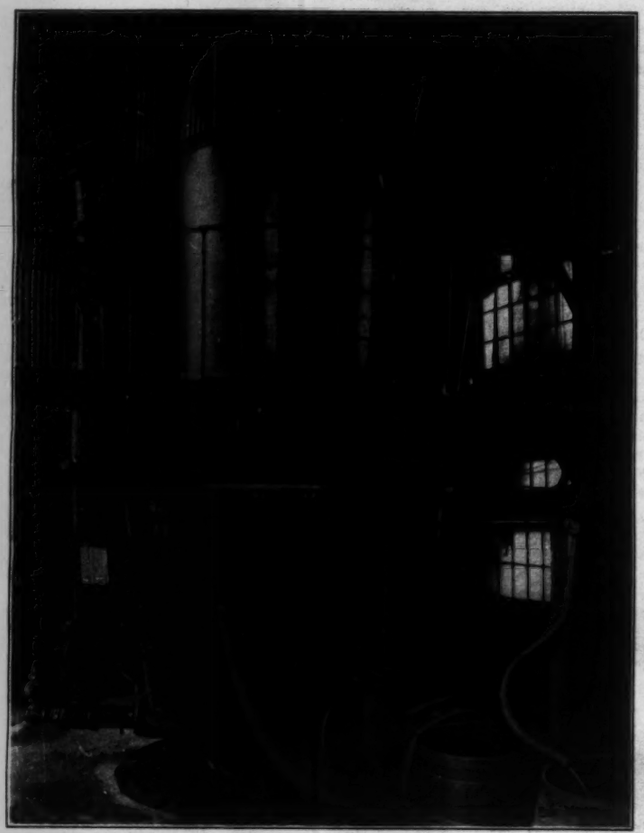


FIG. 2. WESTINGHOUSE DOUBLE-ZONE 175-HP. BITUMINOUS PRODUCER RECENTLY TESTED AT EAST PITTSBURG.

The rotary exhauster serves to provide a positive and uniform suction on the fuel bed. This type seemed to best fulfil requirements and incidentally to avoid the uncertainties of operation encountered with the hand-regulated blower. Thus, the plant becomes virtually a double-zone, suction type. This exhauster, which is motor-driven, operates at constant speed and delivers gas to the engines always at a constant pressure of a few inches of water. This regulation is accomplished by means of a butterfly valve operated by a small gasometer. In this manner such part of the gas delivered by the blower as is not required by the engines is by-passed through a small mixing header overhead and the necessity for a variable-speed exhauster is avoided.

It will also be noted that a gas holder is not employed for the control of gas production as regards quality and quantity or delivery pressure. This reduces the cost of the equipment materially and obviates an exceedingly bulky piece of auxiliary apparatus.

CLEANING.—In the absence of tar, the problem of cleaning the gas suitably for engine use resolves itself into the removal of dust and lampblack. This is accomplished by a static cellular-type washer in which the gas streams are spread out in thin layers and constrained to pass over the surface of still water, during which process the matter held in suspension is thrown down. This has been shown to reduce the quantity of foreign matter to about 0.02 grain per cubic foot, which affords a very large margin of safety in operation. In practice, a large part of the foreign matter is thrown down in the downcomer from the producer to the washer by the action of a water spray (not shown in Fig. 1) and passes freely to the overflow without entering the static washer.

The static washer is practically indestructible and largely self-cleaning, owing to the skimming action at each level. The various sections are readily accessible by lifting off the cover.

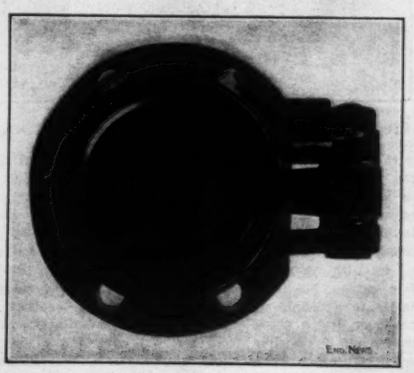
WATER SEALS.—In the purge stack is a single-seated stack valve and this is connected by a rod with the plug valve controlling the water seal between the producer and washer.

The valve controlling the water seal is normally left open. When the plant is shut down, the closing of this valve floods the water seal, thus shutting off the rest of the plant, and automatically opens the stack valve by means of the connecting rod. This water seal makes it possible to work on the auxiliaries while the producer is at stand-by.

The water seal of the producer proper may be partially drained by a rotating valve provided for that purpose. In its "up" position, this valve maintains a water level in the ashpit, as shown in Fig. 1. When turned downward, the water is drained 2 ins. beneath the lower rim of the mantle ring, consequently breaking the seal and allowing free ingress of air at all points. This is effective in the rapid starting of a new fire in which a heavy draft is desirable.

DRAFT.—In normal operation, the pressure at the top fire bed is slightly below atmosphere, so that when the charging cover is opened there is no tendency for smoke or gas to reach the producer room. Thus it occurs that the most important part of the fuel bed is always available for inspection and can be easily worked down in full view. In addition, poke holes at the top, middle and base are provided, so located that the sides of both the upper and lower linings may readily be raked by a poker bar and the ash may be settled down as in the normal operation of a pressure-type producer. These also give access to the fire at these levels —an important feature.

LABOR.—The labor requirements are comparatively small, as the fuel bed seldom requires loosening more frequently than once per hour. Ashes are removed about once in 24 hours. Thus it occurs that, with coal and ash separately handled, one man can operate at least three of these producers without difficulty. Coal may be charged at intervals of from 15 minutes to one hour, according to the load. Owing to the low temperature at which the fuel bed is maintained, the formation of large clinker is entirely prevented, and this trouble has not been encountered in any of the tests. Provision is made for flushing out the vaporizer at intervals to prevent the deposit of mud in case foul water is used.



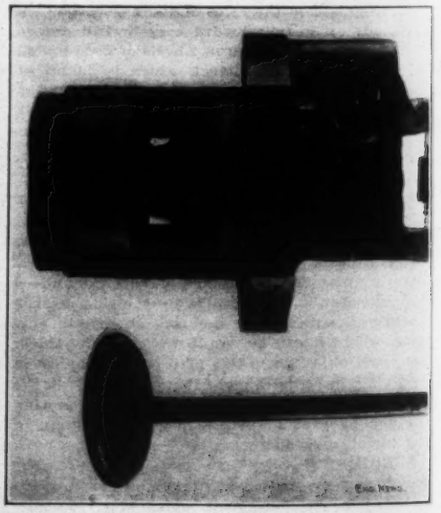


FIG. 3. TWO VIEWS OF INLET VALVE OF ENGINE USED IN TESTS OF DOUBLE-ZONE BITUMINOUS PRODUCER; SHOWING SMALL LAMPBLACK DEPOSIT.

(The valves had been through about 2,000 hours' service without cleaning at the time these photographs were taken.)

Results of Tests.

Reference has been made to various efficiency tests conducted at East Pittsburg. This producer was put under fire in December, 1907. Several weeks' run on Pittsburg run-of-mine at 13,000 B. T. U. per pound as fired gave an average consumption of 1.2 lbs. per B. HP.-hr. continuous operation. After some slight improvements which then appeared to be necessary, the plant was again put into commission on March 31, 1909, from then until April 3, 1909, the fire was never drawn. In the intervening year the following tests have been run with fuels as noted below:

(A) Three 10-hour tests on South American lignite.
(B) Fifteen-day, 24-hour test on Colorado lignite.
(C) Fifteen-day, 24-hour run on Pittsburg run-of-mine. Fifteen-day, ten-hour run on Pittsburg run-of-mine. Thirty-day, 24-hour run on Pittsburg run-of-mine.
(D) Ten-day, ten-hour run on Massachusetts meadow peat.
(E) Ten-day, ten-hour run on Texas lignite.
(F) Forty-five-day, 24-hour run at stand-by, Pittsburg run-of-mine.

The average composition of fuel for each run is given in Table I.

Besides the above, there have been numerous short runs under special conditions to determine the various factors entering into successful operation of the producer. Table II. shows a summary of the tests on Pittsburg run-of-mine and Colorado lignite.

COAL CONSUMPTION.—In general, an economy of about 1.1 lbs. per B. HP.-hr. was obtained on ordinary Pittsburg coal with 24-hour operation. With ten-hour operation, including stand-by of 14 hours, the economy approximates 1.25 lbs. per B. HP.-hr. For lignite the economy averages 1.6 lbs. per B. HP.-hr. continuous service. The stand-by loss, when under proper draft, is extremely light, averaging for a 175-HP. producer 10 lbs. per hour by actual test of a month's duration, and this includes the gas lost by blowing up the fire each morning of stand-by run.

EFFICIENCY.—The efficiency of the producer did not vary more than 10% from full load to no load on the plant and approximates 77.5% on total heat value, or 71.5% on effective power value basis. Samples of refuse taken from the producer during the tests on Pittsburg run-of-mine, show the following composition for an average of six samples:

Ash, 85.1%; fixed carbon, 14.9%. As the original coal contained about 7% ash, the actual percentage of combustible wasted was $14.9 \times 7 \div 93 = 1.1\%$.*

COMBUSTION RATE.—The rate of firing varied from 13 to 22.8 (averaging 18.5) lbs. per square foot of fuel-bed area per hour at the green fuel zone. This higher rate might have been maintained indefinitely without vitiating the gas by excessive oxidization and without clinker formation. The temperature of the gas leaving the fuel bed averaged about 900° F., low enough to prevent clinker. When the fire was allowed to become hotter, the heat value of the gas fell slightly. This temperature therefore serves as a fair index of practical limits in regard to fuel-bed temperature.

HEAT VALUE OF GAS.—The average samples of gas taken from the engine show a heat value of about 115 B. T. U. effective power value; a considerably higher value could be obtained by using more vapor and producing higher hydrogen content. But high gas was not desired, as it would not permit the use of as high compression in the engines, for which a gas of moderate heat value is better suited.

BRAKE TESTS.—During all the tests a 175-HP. engine was kept under brake load, receiving all of the gas from the producer except when the latter was being forced beyond the capacity of the engine. In this way was provided a practical demonstration of the gas quality. As the engine gas was metered in both gas-house and engine-house, a check was thus available between

*Apparently from the data given the percentages of combustible wasted should be $14.9 \div 85.1 \times 7 \times 100 \div 93 = 1.3\%$.—Ed.

TABLE I.—AVERAGE COMPOSITION OF FUELS.

Runs.	A	B	C	D	E	F
Moisture	20.05	16.63	2.03	38.10	34.09	2.03
Volatile	34.44	33.78	34.98	40.54	30.03	34.98
Fixed carbon	30.85	42.22	56.22	17.86	26.32	56.22
Ash	14.66	7.37	6.77	3.50	9.56	6.77
B. T. U. per lb. as fired	8,032.00	8,599.00	13,305.00	6,410.00	6,950.00	13,305.00

the two meters, and the extra load upon the producer was determined.

FOREIGN MATTER.—Under normal working, the average gas samples at the discharge of the exhauster showed from 0.015 to 0.025 grain of solid matter per cu. ft. of standard gas. During a week's test on the auxiliary washing plant, 25 determinations showed a range of solid matter from 0.006 to 0.043. This solid matter contained no tar, consisting entirely of dust and lampblack. The greater part of the heavier matter is generally thrown down at the discharge nozzle of the producer by a water spray.

EXAMINATION.—This producer was opened on April 3, 1909, for the first time in one year. During this time the producer had been under fire continuously, under various operating conditions from maximum load to no load. There had been no repairs to the producer lining or other parts during this time of operation. The shutdown was made in the presence of a number of officials of the U. S. Geological Survey, as well as some prominent commercial representatives. After examining the producer and noting the normal condition of the fuel bed, the quality of gas and the load carried by the engine, the fire was pulled, affording a demonstration of the condition of the fuel bed inside of the producer after this long run. It was found that the producer lining was practically intact even in the regions of the hottest fire zones. The wall of the evaporator was also in good condition, as were the tuyères at the bottom. Previous to the demonstration, the plant had been in operation only ten hours a day for about one month, and, although a straight air blast was employed in starting up, practically no clinker was found in the entire fuel bed. From 1 or 2 ft. above the lower tuyère the fuel was practically all coke in the various stages of formation, from ash at the bottom to green coke at the top. No ash was found in any of the fuel bed proper, while the largest piece of clinker found was hardly over 6 ins. in diameter. No clinker bridge formation was formed across the fuel bed, and at no time was it necessary to rake the fire or ash down. There was no difficulty in removing all of the fire bed, which settled down as the ash was removed, only 45 minutes being required to do this work.

The producer after a year's run could be put in operation again for an indefinite period. A small amount of material clung to the lining at the fire zone, but most of this was coke and could readily be broken off, thus distinguishing it from fused clinker. An examination of the lower zone of the producer showed that the region where material was adhering to the fire-bricks was that which could not be reached by the poker bars. Where it was possible to rake the walls, all ash and clinker were readily removed.

The interior of the static scrubber was examined. This had been in operation for practically four months, during which time Pittsburg coals, lignite and other materials had been tested. Only a slight deposit of sludge was found covering the perforated plates. During these four months the total drop in pressure through the scrubber had increased almost 4 ins. due to the deposit that had gathered. The material found consisted largely of lampblack, with a very little evidence of tar formation. This is not extraordinary, for the reason that during part of the test, especially with refuse and high volatile fuels, the fires had to be started without the use of steam and with a shallow fuel bed, so that some deposits of tar might have been expected under the circumstances.

On the following day, the water vaporizer was also examined internally. There were no cracks visible next to the hot fire and no hard scale in the interior. In the bottom of the vaporizer there was a small deposit of sludge, but this was quite soft and was easily flushed out with a hose. The construction of the vaporizer with loose covers made it an easy matter to examine the interior at any time and remove any material scale or hard deposit that might tend to form.

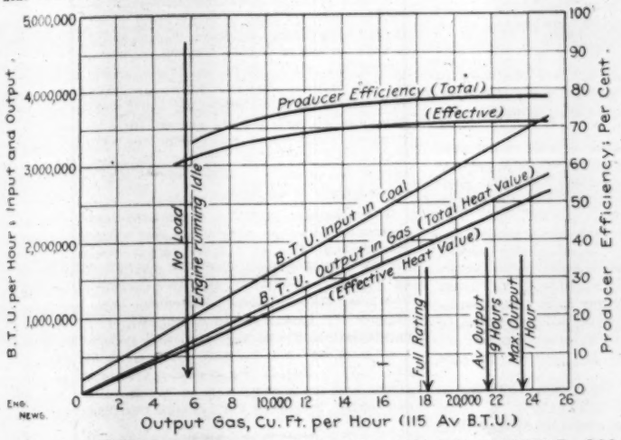


FIG 4. CURVES SHOWING EFFICIENCY OF DOUBLE-ZONE GAS PRODUCER WITH PITTSBURG RUN-OF-MINE COAL.
(Based on continuous tests of from 15 to 30 days' duration.)

Perhaps the most interesting exhibit was the condition of the inlet and mixing valves of the engine used on the test (Fig. 3), and of the piping and manifold. The valves had been last examined in July, 1908, after having been in operation about 1,000 hrs. During the period from July, 1908, to April, 1909, the plant was operated intermittently, the number of hours in service aggregating about 1,000, as in the previous run. At the time of the present examination (April, 1909) the condition of the valves was found to be the same as noted in July, 1908.

SUMMARY.—The most important points developed from the tests and examination of this type of producer are the following:

(1) Continuous operation, producer under fire twelve months without cleaning.

(2) No short time tests, but from ten days to a full month.

(3) Performance tests under actual commercial conditions without the formation of tar or clinker.

(4) Low-grade fuels successfully gasified.

(5) An average economy of slightly over 1 lb. per B. Hp.-hr. for continuous operation, 1.25 lbs. for ten-hour day, including stand-by loss, for average bituminous coal.

(6) Gas quite clean, uniform in constituents and free from tar.

(7) Commercial value of the gas actually tested by a gas engine of standard construction.

(8) Regulation of heat value and pressure, automatic without gas holders, varying only 10% from full to no load on plant.

(9) Efficiency of producer reasonably high.

(10) Labor required exceptionally small, one operator to three units.

(11) Deterioration after one year's operation practically nil.

TABLE II.—TEST ON BITUMINOUS PRODUCER.

Coal	Pittsburg Bituminous		Colorado Lignite.
Date of test	May 8-23	August 4-25	April 16-29
Hours per day	24 hrs.	10 hrs.	24 hrs.
Total hours	297.75	514.0	314.0
Engine running hours	239.5	168.5	312.75
Hours shut down	58.25	345.5	1.25
Pounds coal fired	53,935.0	35,647.0	60,939.0
Total running coal	....	31,143.0	....
Stand-by coal	....	4,504.0	....
Pounds of coal per B. HP. Total	1.12	1.24	1.61
Pounds of coal per B. HP. Net	....	1.08	....
Producer efficiency (per cent.)	77.0	....	78.5
Combined efficiency, including stand-by (per cent)	17.0	15.74	16.6
Excluding stand-by (per cent)	....	17.91	....
B. T. U. in coal	13,305.0	13,143.0	9,589.0
Ash in coal	6.77	10.76	7.37
Fixed carbon in ash	....	14.9	....
Percentage of carbon lost	....	5.92	....
Average load on producer (HP.)	172.0	170.0	122.0

Fuel Economies on the Locomotive.*

The base of the whole question of fuel economy is contained in beginning at the mines, so as to be absolutely sure that no imposition is practiced by having noncombustible material palmed off for coal, and to see that the coal is properly cleaned. To do this it will be found necessary to keep competent inspectors at the mines with authority to reject all coal before shipment that does not come up to certain standard specifications upon which all coal should be purchased.

Under the old plan of purchasing coal, when the consumer (in this case a railroad company) had cause or thought they had cause to find fault with the quality of coal received, every one whose duty it was to supervise and look after its use was at once assured that the coal must be good, because, like all the coal sent forward, it came from a mine with an established reputation, and the mine owners and their representatives frowned down any attempt on the part of the company to condemn any of their product. It is obvious that such a state of affairs would make it very difficult to take advantage of the competition which usually results when a considerable number of bidders are asked to submit prices. The purchaser was afraid to buy from any but such dealers as he knew and trusted, for the reason that although each dealer claimed that his coal was of as good quality as any other, yet when it proved to be unsatisfactory there was no standard for settlement or for abrogation of contract. Many thousand dollars' worth of fuels are bought each year in this manner, but the purchaser would think it unwise, or even ridiculous, if he was asked to let a contract for the building of a house, or, in fact, any building with no specifications, but simply on an agreement that it should be of a certain size and dimensions and be well built. Neither would they purchase gold, silver, or even copper and iron ores simply on the knowledge that they were mined in a certain locality. It is believed that the time is rapidly approaching when the production of all mines will be purchased upon their value as shown by a complete chemical analysis. This is true of coal at the present time only to a small extent, but the number of contracts made based upon the number of B. T. U.'s that can be furnished for one dollar is bound to increase every year. The road above referred to furnishes data sheets showing just what B. T. U.'s are furnished in each kind of coal used for one dollar to officials engaged in the extension of fuel economy. The purchase of coal on specification is as much of an advantage to a railroad company, or to any buyer, as a definite understanding of a building operation or engineering project is to the engineer, because when coal is bought to a specification you get what you pay for and pay for what you get.

When the bidder is allowed to specify the quality of coal he proposes to furnish as determined from a chemical analysis, he is placed on a strictly competitive basis with other bidders. This broadens the field for both the bidder and the purchaser. It makes the bidder's proposal, when accepted, a contract which specifies an established standard of quality. This furnishes a basis for settling disputes regarding the coal delivered and the price to be paid if the fuel is either better or poorer than has been guaranteed. If other coal must be substituted, as often happens, there is a basis of settlement. If the coal is uniformly poorer than the standard as specified, there is a basis for cancellation of the contract. The cities of Chicago, Indianapolis, Minneapolis, St. Paul, St. Louis and Cleveland purchase coal on this basis, as do some of the other large cities. There is, however, some variation in the B. T. U.'s allowed by the different cities which purchase coal on this plan, but in general a standard is fixed at nearly 14,000 B. T. Us. Coal falling below that standard may be used or not by the purchaser. If, when an inferior grade is used, an average is struck when the monthly settlements are made, it can be plainly seen that the material reduction in the prices of the coal will soon cause the mine owners to sit up and take notice. The result will be that the standard fixed in the bid will be maintained.

One of the essential things which many of the railroads are now trying to establish is to figure on the grade of coal best suited to a certain territory, then to assign this coal to that territory and have it definitely understood that no change will be made except in case of a grave emergency, such as a miners' strike, floods, storms, washouts, etc. This will enable engine crews to become acquainted with the quality of fuel furnished. Engines can then be drafted to suit, and thus insure greater improvement in fuel economy than if the old plan were continued.

The proper essentials of fuel economy and the conditions obtaining in a locomotive boiler on which that depends, should be as follows:

1. A clean boiler whose shell tubes, sheets, and stays (and in addition "the crown bars," in the crown-bar type of boiler), are kept free from mud and scale.
2. Properly drafted and good steaming engines.

*Portion of Report of Committee on Fuel Economies presented to 42d Annual Convention of American Railway Master Mechanics' Association, Atlantic City, N. J., June 16-18, 1909.

3. A good quality of fuel properly prepared for use.
4. Efficient operation of the locomotive.
5. Individual fuel records.
6. A full and fair accounting.

Economy in the use of fuel on a railroad is at all times a very interesting, though perhaps a perplexing, problem. There are so many items which enter into its make-up, both from a mechanical and an operating standpoint, that the fuel question is always bobbing up serenely and presenting itself for solution. The fuel account being one of the chief items of expense on every railroad, all officials having charge of train and engine men should work together in order to secure best results. To do this, we are very much inclined to think there should be a mutual understanding concerning the leaks, and a combined effort should be made to stop every one of them.

A CLEAN BOILER.—Mr. M. N. Forney, one of the foremost mechanical engineers and writers of the present age, stated that a locomotive engine consists of three parts, namely, the boiler for generating steam, the mechanism for utilizing the steam—i. e., the engine proper—and the wheels, frames and springs which constitute a vehicle to enable the whole to move from place to place.

The first essential to be dealt with in considering the question of fuel economy is the boiler or source of supply. Locomotive boilers all belong to the multi-tubular class with internal fire boxes. At the present time, however, there are five types of boilers in general use: First, the straight top variety; second, the belpaire, or square wagon top; third, the wagon top with the wide fire box, commonly called the American type; fourth, the extended wagon top; a type used somewhat extensively on eastern railroads, especially in the anthracite regions. Of course, the extended wagon top with radial stayed crown sheet probably gives the best satisfaction in general use.

The reason that it is so important that the sheets be kept free from mud and scale is that the heat given off by the burning of the fuel may be more readily absorbed by the water through the sheets than would otherwise be absorbed by the mud and scale, representing an absolute loss in heat and a consequent waste in fuel, with all the other evils which travel in the wake of boilers not properly taken care of, such as leaky flues, stay bolts, and fire-box sheets, which carries with it the delays on line incident to that condition of boiler.

The design of a locomotive boiler should be such as to give as large a heating surface, both box and tubes, as possible with large grate area, in order to provide for a slow rate of combustion. Provision should also be made for a good free circulation of the water and also to see that flanges are properly turned, so that no traps are formed to accumulate dirt and scale. The care of the boiler should be closely looked after, both as to proper blowing out at terminals and on line during every trip. This, together with good washing at terminals and proper care in handling, will extend its life and usefulness and materially aid fuel economy. The study and attention now given to locomotive boiler design as compared with some years ago is marvelous. This is a good thing. The care now given to locomotive boilers in service by all railroad companies will undoubtedly materially assist in the promotion of fuel economy.

PROPERLY DRAFTED ENGINES.—Improperly drafted engines are, perhaps, one of the greatest sources of trouble on many of our railroads to-day. It therefore goes without saying, that it is entitled to and requires constant and close supervision and attention, because on account of some defect in the draft apparatus that has escaped notice, much waste of fuel occurs.

Insufficient draft may be caused in a number of ways. First, in the fire box, by the grates being clinkered. Second, by the heat of the fire not being fully utilized by the engine crew not being educated up to a point of appreciating the importance of the subject, or through their neglect of the proper essentials of fuel economy in the performance of their work. Third, through a lack of the proper vacuum being formed in the front end or smoke box by the exhaust steam.

The proper remedy can and must be applied after a thorough investigation of the subject has located the difficulty.

It is not considered necessary in view of the knowledge of the members of this association concerning draft appliances, to mention the value of the different devices other than to say that what is known as the Master Mechanics standard, strictly adhered to, gives most satisfactory results.

A GOOD FUEL PROPERLY PREPARED FOR USE.—In order to get the best results, the coal should be placed on the tenders of the engines in such a size that the fireman can devote his entire time and attention to watching and feeding the coal to the fire. Anything which interferes with his doing so is at the expense of a certain amount of coal wasted. We do not undertake to say how the above can be accomplished on any railroad, on account of the different methods of handling fuel, employed on docks or coal tipples, and thence to the tenders of engines, but we contend that the better the coal is prepared before being placed on engines the more economical its use will be. The first section of the proposition hardly needs restating, that is, furnishing a good grade of fuel tends to its economical use; it is our firm belief that all classes of enginemen will do better work, and will use greater effort to save the good coal in all ways than will be the case when a poor grade of fuel is furnished. We are fully aware, however, that in some instances this has not proved to be the case, but the causes which led up to that belief are so indefinite as to be of no value in determining the above question. If this is true, it follows, then, that the proper preparation of coal for firing has considerable influence on the completeness and rapidity of combustion, and consequently on the temperature obtained in the fire box and on the prevention of black smoke.

The rapidity with which a lump of coal will burn depends, among other things, on the amount of its surface presented to the fire, so that if the lump is broken into a number of small pieces it follows that it will present a much greater surface, will burn faster, and will create a much higher temperature with the same quantity of coal on the grates. Other advantages are that the smaller coal can be spread more evenly over the fire, a thinner fire can be maintained and the thickness of the fire can be regulated more readily for the proper admission of air through the grates, thereby securing a higher and more even temperature in all parts of the fire box, and, as naturally follows, also a better combustion of the fuel.

The portion of the air supply furnished through the ash pan cuts a very important figure, and, doubtless all will agree, is very essential in assisting combustion to an extent that the best means for furnishing it should receive considerable attention.

EFFICIENT HANDLING.—This involves the work of both the engineer and fireman, and, to our minds, constitutes one of the most, if not the most important element in fuel economy.

The question of running an engine in order to get most economical results involves the work of both the engineer and fireman, and is so important from that point of view that we shall introduce this portion of the subject by making the following statement:

An engine may be built of the very best material, and of the most approved design, i. e., mechanically perfect, with all the modern conveniences to assist in its perfect manipulation, and you place that machine in the hands of an incompetent engineman and you have almost nullified the combined expert mechanical skill necessary to turn out the finished product. We think you will all agree it is most important that the finished machine should have skilful operation.

Naturally the question will be asked, how can this be accomplished? To our minds, the answer is plain enough. It is largely a question of education by beginning with the future engineer and training him from the time he enters the service in the way you would have him go in regard to the duties of a fireman, and subsequently with regard to the duties of an engineer, establishing an educational qualification as a condition of employment, and later requiring such examinations from time to time as will tend to bring his fitness for the duties of a fireman, and his application of the same, into definite shape.

Our reason for stating when we opened the question of the operation of locomotives, that it involves the work of both the engineer and fireman, is as follows: The manner of firing and feeding water to a boiler has much to do with its steaming qualities. To get best results, these two operations must be performed in harmony with each other.

Did you ever stop to think what it is costing railroad companies for the steam wasted through pop valves unnecessarily? If you have not, the following figures will doubtless surprise you. The figures can only be based on estimates as to the number of engines that may be included in the list. It is conceded by all conversant with the facts that nearly 15 lbs. of coal are wasted through a 3-in. pop valve every minute during which it remains open, and a pop rarely opens and closes in less than a minute. Our observation, as far as the control of pop valves is concerned, unless exceptional care be practiced, is that 3% of the boilers [illegible] any railroad are blowing off continually during [illegible] hrs. If this be true, a few figures will demonstrate [illegible] what the waste is: 2% of 1,000 engines is about [illegible] mber that will be found to be blowing off day and n[illegible] This we consider a conservative estimate. This wo[illegible] waste in the vicinity of 78,840 tons of fuel per y[illegible] com-puted on the present average price per ton would [illegible] mount to the snug sum of $111,164.40. Just think [illegible] paying that amount for a leak which ought to be st[illegible] and can be, if all railroad officials will unite to sto[illegible] Is it worth the effort? We are inclined to think you will decide in the affirmative.

INDIVIDUAL FUEL RECORDS.—This subject has a far greater influence on the coal pile than one would think possible at first blush. Our plan would be to have a performance sheet showing the individual fuel record of every engineer and fireman on each district, the coal to be charged to the engineer instead of the engine as at present, establishing an average—a maximum and a minimum cost per ton-mile on each district.

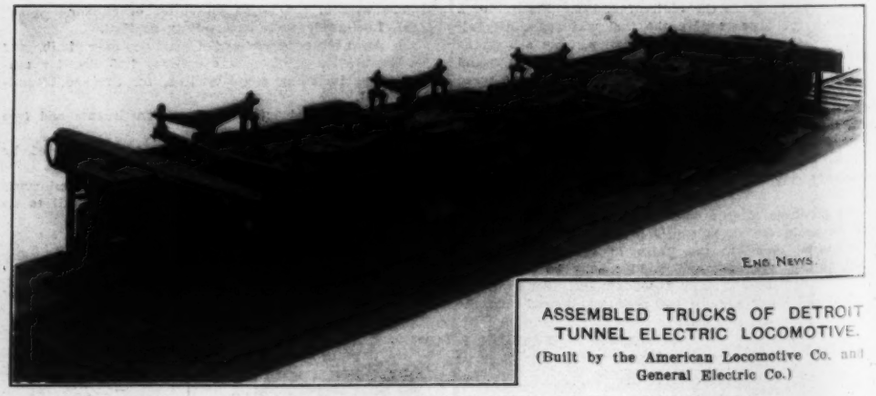
We are fully satisfied that, after this sheet has been issued a few times so as to give enginemen an idea of its working, it will stimulate a great interest in the direction of fuel saving. Once let it be understood that such a scheme is on foot, and it will establish a spirit of competition among the men that will mean dollars to the company.

FULL AND FAIR ACCOUNTING.—This is an item having considerable influence on the fuel. Let the idea become circulated among the enginemen that they are getting the worst of it, in having more or less coal charged to them than should be the case, and you will find that it has a disheartening and a demoralizing tendency, which will militate against the coal pile by creating a "don't care" spirit indicated by the idea that they do not get credit for what they do. This feeling should be carefully guarded against, as it creates an outgo instead of an income.

In conclusion, let it be emphasized that, after going thoroughly into the subject of fuel economy as far as the practical side of it is concerned, we will say that we are of the opinion that best results can be obtained by having the engineers and firemen subject to instruction from the mechanical department only; and for this purpose the road foreman of engines should be on the mechanical staff and report to and receive his instructions from the chief mechanical officer, or his representative. When this is the case the field work is not divided, and much more can be accomplished than when the subject is worked out between two departments.

Detroit River Tunnel Electric Locomotives.

A design of direct-current locomotive, developed for the tunnel of the Michigan Central Railroad under the Detroit River, was described in our issue of one week ago. One of the interesting features there disclosed was the load equalizing system of the truck frames. It will be remembered that this gave the effect of a two-point suspension for the forward truck, a three-point for the rear and a compound three-point for the articulated running gear as a whole. In the accompanying figure the description in the issue of June 24 is well illustrated. The disposition of the air-brake cylinders is shown here better than in the general view with the earlier article.



ASSEMBLED TRUCKS OF DETROIT TUNNEL ELECTRIC LOCOMOTIVE.
(Built by the American Locomotive Co. and General Electric Co.)

The weights of the truck and locomotive are divided as follows::

	Lbs.
Motor and gear cases	10,000
Trucks and motors complete	133,000
Cab and auxiliary apparatus	66,000
Locomotive, total	199,000

ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering

Published every Thursday by

THE ENGINEERING NEWS PUBLISHING CO.

220 BROADWAY, NEW YORK

BRANCH OFFICES

CHICAGO: 1636 Monadnock Block
WASHINGTON, D. C.: Home Life Building
SAN FRANCISCO: Monadnock Building
ATLANTA: Candler Building
RUDOLPH MOSSE, BERLIN AND HAMBURG, GERMANY
Z. P. MARUYA & CO., Ltd., TOKYO, JAPAN

GEORGE H. FROST, President
CHARLES WHITING BAKER, Vice-President
HARWOOD FROST, Secretary
FRANCIS W. FROST, Treasurer

ALFRED E. KORNFELD, Manager
EDWIN HUNT FROST, Ass't Manager

CHARLES WHITING BAKER, M. N. BAKER, E. E. R. TRATMAN, F. E. SCHMITT, } Editors

SUBSCRIPTIONS

United States and Possessions, Mexico and Cuba, One Year, $5.00.
Canada, $7.00 a Year.
Foreign Countries, Regular (Thick Paper) Edition, One Year, $9.00. (£1-18-0.), 45 Francs or 37 Marks.
Foreign Countries, Thin Paper Edition (Construction News Supplement Omitted), $7.00. 29 Shillings, 35 Francs or 29 Marks. Remit directly to our office.
Pay no money to canvassers for subscriptions.
Remit by Post-Office or Express Money Order, Draft on New York or London, or by Registered Letter.
Notice of change of address should reach us one week in advance of removal. The old as well as the new address should be sent.
Subscriptions cannot be dated to commence with past issues.
All subscriptions commence with current issue and back numbers can be supplied only by special order.
Receipts for Subscriptions will not be sent unless requested, the changing of the expiration number being considered sufficient. The number on the address label indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year. 52-9 means the 52d week or December 26, 1909.

ADVERTISING

"Contract": Rates furnished on application.
"For Sale": $1.50 per inch.
"Proposal": $2.40 per inch.
"Want": See "Want" Pages.

Copy for regular, or "Contract," Advertisements should be received at least ten days before publication; "For Sale" and "Situations Wanted" Advertisements by Monday, and "Proposal" and "Situations Open" Advertisements by 9 A. M. Wednesday.

Entered at the New York Post-Office as Second-Class Matter.

In the hands of English engineers the open caisson pier shows a surprising degree of adaptability to bridge work under most varied conditions. Some typical instances of its use are noted in the article on British bridge-building which appears on another page. More striking examples come from India, where this type of pier is almost universal for bridges over the large rivers, and many of them have been described in the Proceedings of the Institution of Civil Engineers.

These India piers in nearly every case were sunk by open dredging; but it is one of the specially valuable features of the cylinder caisson pier that it lends itself equally well to open excavation and compressed-air work, and, what is yet more valuable, enables the constructor to change from one method to the other at any time after starting, when the conditions seem to call for change of method.

It is a very curious fact that in America the cylinder caisson type of foundation is employed so rarely as to make it almost unknown. The steel cylinder pier, used most widely in the Mississippi Valley, may be regarded as a close analogue in those cases where the soft soil is so shallow that the cylinders are sunk to their own bearing on the underlying hard soil, the foundation thus being a self-contained one. Even in these cases, however, there is a fundamental difference between the cylinder caissons of English practice and the concrete-filled (or sometimes merely stone-filled) mold-cylinders which make up our typical steel cylinder piers. And in the general case the steel cylinder pier is entirely unrelated to the open cylinder caisson in question, but is in fact a modification of the pile foundation; the cylinders are simply a special form of pier-shaft and have nothing to do with the means of getting a bearing in the underlying soft soil (piles being used for this purpose).

Foundations in water are subject to so much difficulty, so many variations and vicissitudes, that it is valuable to have at command a variety of different constructive methods. The more are available, the better chance of finding for any particular case the method best suited to it: simplest, safest and cheapest. Surely the open cylinder caisson type of foundation, with its combination of simplicity and wide adaptability, merits a prominent place among the available methods of construction. Its utility is abundantly proved by its use in England and in India. Yet, under exactly the same conditions in America it would not have been used. In some of the cases the piers would have been founded on piles, in other cases on the conventional pneumatic caisson; and it is highly probable that the first would have been less satisfactory and strong, the second slower and more costly.

The fact is that in America pile or pneumatic caisson foundations reign to nearly complete exclusion of everything else. We suspect that this is so because pile work is greatly overdone. There is ground for believing that in many cases where piling is used it is poorly adapted to its service. Occasional troubles with pile foundations strengthen this belief. Caisson foundations are generally impracticable or too expensive in these cases. It seems probable that greater familiarity with the open cylinder caisson method of pier foundation would make it find useful application in many such cases.

The Baldwin Locomotive Works of Philadelphia have for many years been remarkable for adhering to the old partnership form of organization. The business founded in 1831 by Matthias W. Baldwin, a Philadelphia machinist, was carried on by him with various partners until his death in 1866, and was then continued under a partnership made up of men who had been associated with him in the business. The firm of Burnham, Parry, Williams & Co. was formed in 1873, after the death of Matthew Baird, one of the original partners with Mr. Baldwin, and with various changes made necessary by deaths, withdrawals and the addition of new blood, the partnership organization has been continued to the present time.

Announcement was made, however, on June 29 that the business is to go the way of all other large industrial enterprises and assume the corporate form. The present partners are Messrs. John H. Converse, who has been connected with the works since 1870, and was admitted to partnership in 1873; George Burnham, Jr., son of one of the original partners who was associated with Mr. Baldwin in the works at a very early period; Wm. T. Austin, who entered the works in 1870 and has been a partner in the firm and active in the management since 1886; Samuel M. Vauclain, who has long been the Superintendent of the shops and to whose inventive genius some of the noteworthy departures in locomotive construction are due, and Alba B. Johnson, who has been prominent in the business management of the works for 25 years.

While the business has been incorporated, the present partners continue as owners, directors and officers of the new corporation, Mr. Converse being President. The capital of $20,000,000 which the firm has had invested in the business will be the capital stock of the new corporation, and no stock or bonds will be placed upon the market. The new company takes over all the property of the old firm, including the locomotive building works located on North Broad St., Philadelphia, and at Eddystone, Pa., with a combined capacity of 2,650 locomotives per annum, and the Standard Steel Works, makers of steel tires, springs, car wheels, etc., at Burnham, Pa.

Laboratories for the analysis and study of various specimens and materials are fast becoming an indispensable adjunct of municipal institutions. By no means all of our larger cities have all the proper laboratory equipment and personnel for most efficient service. In the smaller cities such laboratories are frequently entirely lacking in many of the departments that need them, and such as have been provided are quite likely to be inadequate.

Cities suffering in this way could profit by the example of Brockton, Mass. Here there has been combined for a number of years past, in one laboratory, a considerable variety of analytical work done for the health, water and sewerage departments. The laboratory in the first instance, if we rightly remember, confined its work to sewage analysis in connection with the well-known intermittent filter beds built fifteen years ago by the city. Since then the laboratory work has been extended to the other departments named.

The report of the laboratory for the year 1908 shows that besides many of the routine water and sewage analyses that might be expected, and in addition to a variety of work for the health department, there were made a number of coal analyses, together with investigations designed to assist in perfecting specifications for oil used by the water-works department.

A notable feature of the report is the valuable material which it contains on the character of the milk supply of Brockton during the year 1908. This information will enable citizens who are wise enough to use it, to choose their milk dealer with a discretion based on exact knowledge of the economic and sanitary character of the product delivered. Such information is rare in city reports, but it is to be hoped that the time will speedily come when all health or other departments responsible for the character of a milk supply will have the courage to give the public information which it needs to enable it to choose a milk supply which has not been robbed of its nutritive value, and, more important still, is clean, non-fermentative within reasonable limits, and as free from pathogenic germs as can be determined by present methods of analysis and inspection.

We commend this Brockton report and the work which it describes to the attention of city engineers, water, health and other municipal departments throughout the country. It is only fair to add that Mr. George E. Bolling is chemist and bacteriologist in charge of the laboratory, and that he has been connected with laboratory work for many years past.

The Freight-Car Surplus and Car Efficiency.

The statistics of idle freight cars which have been collected and published for some time by a committee of the American Railway Association are very well worth while. These statistics present some valuable information to railway men. The general public, however, has come, unfortunately to take the figures as an index of activity or depression in railway business and by analogy in business generally. Of course this conclusion is a natural one. A person recalls the great shortage of railway cars in 1906 and the early part of 1907, and comparing it with the present calculated surplus, makes the plausible analogy: 1906, boom year, car shortage; 1908, dull year, car surplus; hence car surplus is an index of business depression.

But before concluding that these strings of empty cars on out of the way sidings are a real indication of bad times, we ought to make sure that conditions are the same in the two periods we are mentally comparing. In the boom period of 1906, when shippers were tearing their hair because they couldn't get cars to handle their goods, when towns in the Northwest were burning buildings and fences because the railways couldn't get cars to haul them coal, when Georgia peaches rotted in the orchards because the cars were not to be had to take them to market—when these things were occurring, cars were also standing on side tracks, and were nominally in service; but actually they were tied up by glutted yards and deficient motive power.

If then, under present conditions, the cars which are running are making more miles per day and carrying more freight, perhaps there is no such great contrast between the railway traffic of 1906 and 1909 after all.

The able committee above referred to is also collecting statistics of car efficiency and these monthly car-efficiency reports show a steady increase of daily mileage and of ton-mileage per car throughout 1908. In December, 1907, the average car ran 23.2 miles and made 316 ton-miles per day; i. e., it carried a load of 13.6 tons.

But a year later, in December, 1908, this average car traveled 25.2 miles per day (8.6% more), and made 376 ton-miles (19% more), its load being 14.9 tons (9.5% greater). During the year, therefore, the railways greatly improved their car operation, and at the end were getting nearly one-fifth more work out of each car actually in service.

If this improvement had not been made; if the ton-mile performance of December, 1907, had been maintained unimproved under the traffic of December, 1908, the rolling-stock available would not have been able to accommodate the traffic. Instead of a surplus of 150,000 to 200,000 cars last December there would have been a shortage of about the same amount. This shortage would have continued throughout the winter and spring, and we should now be facing an increasing traffic and a prospective heavy fall movement of freight with no means of handling it. Every one would argue prosperity from such a car shortage. But the fact is that the actual condition of the railways is better: they move the same traffic without the inconvenience and heavy expense of congested yards, and with a comfortable reserve of cars to meet the requirements of the crop season.

Is it not a fact that a surplus of cars ought to be a normal condition for railways, at least during the spring and summer months? If not—if the railways own only enough cars to move the average traffic, then they will be swamped by the slightest upward turn in business. All business men are familiar with the many delays, losses and inconveniences which result from freight car shortage. These results occur in minor degree even before a general shortage occurs. Shippers are best served when the railways have a stock of cars idle and ready for service, and this can only occur when there is at least a normal percentage of surplus.

The present surplus is about 12½% of the total number of freight cars. In addition, about 7% of the total cars are in course of repair; but this figure can hardly be reduced materially. While the Car Efficiency Committee of the American Railway Association has assumed that 5% is a normal percentage for "shop" cars, its assumption is only an arbitrary one, and in view of the fact that for two years the shop cars have remained above 7% we may reasonably take the present 7% as the normal. The real surplus, therefore, is limited to the 12½% above noted.

That this is not far from a normal or needful surplus appears from the following: In the fall of 1908, under crop conditions by no means of the best, the increase of traffic which always comes at this time of year reduced the surplus to 5%. Had there been larger crops and a slightly greater activity in general trade, the remaining 100,000 cars would have been pressed into service, and car shortage would have begun. This means, of course, that a really heavy fall traffic would swamp the railways, as it did in 1906, lasting on far into 1907.

It is true that a decreased surplus in the next report would imply an increase of business, but it does not follow that the total disappearance of the surplus is desirable. On the contrary, car building ought to go on before a car shortage comes. The maintenance of a surplus approximating 100,000 cars, or say 5%, is necessary to efficient traffic handling and public service.

A Shady Side of British Municipal Government.

Only a very poorly-informed person, or a dreamer, believes that everything connected with British municipal government is or approaches very nearly to the ideal. Numerous instances come to our attention, from time to time, of very unsatisfactory conditions of tenure of municipal office in English cities, including sometimes that of the town or city engineer. We have no instances in mind at present as regards city engineers, but in our issue of April 15, 1909, we made quotations from the British Local Government Board report which showed some very unsatisfactory conditions as regards the public-health inspection service.

We are indebted to the London "Surveyor" for an example of the extent to which special local interests hamper building inspection and sanitary work in some British municipalities. The instances recounted are drawn from a report of Dr. J. Spencer Low, one of the medical inspectors of the Local Government Board. Dr. Low cites a local government body composed of 32 members, eight of whom were builders, one a painter, one a slate merchant, one an architect, one an engineer, and the balance either representing various professions or occupations or else being "gentlemen of independent means." For some strange reason which we cannot give, this local government body had a sanitary committee consisting of 18 members, or more than half the whole council. Stranger still, all eight of the builders, together with the architect and the slate merchant, were members of the sanitary committee. This committee, it appears, passed upon building plans, and in doing so overlooked many violations of the "by-laws." The peculiar constitution of this committee was not confined to one year, for from 1898 to 1907 the representatives of the building trades made up more than 50% of the membership of the committee at more than one time. Worse still, much of the work of this committee was done by subcommittees, and these subcommittees were oftentimes wholly made up of members of the building trade.

We cite this instance (1) to show that there is a dark as well as a bright side to British municipal government—a fact which Dr. Albert Shaw and many other writers on foreign municipal government have entirely overlooked; and (2) to raise a question as to whether here is not a weak spot in a vital part of the framework of British municipal government.

Dropping the first of these points from consideration, we may mention that in the extended editorial discussion of American municipal charters in our issue of March 25, 1909, we referred to the fact that for a hundred years American municipalities have been trying to get away from the general scheme of municipal government which seems to have given eminent satisfaction during all that period in British cities—or, at least, satisfaction since the municipal reform movement which occurred at the close of the middle third of the 19th century. That is to say, we in this country have been insisting more and more strenuously, particularly in the last ten or a dozen years, on the necessity of separating legislative and executive functions. In contrast, the English town, borough and city councils have continued to exercise both functions and with generally accredited success.

We think the facts brought out in Dr. Low's report, as cited above, show that there is at times a fatal weakness in the British scheme of combining administrative as well as legislative functions in the municipal council. Free as the British cities are, as a rule, from the more sinister influences of party politics and from at least all the worst forms of graft, it nevertheless appears that their municipal administration frequently suffers, especially, perhaps, in the smaller places, from conflict between the interests of good municipal administration and of members of the councils in their private trade capacities. Now, with the generally high character of the British municipal service, if the execution of the policy determined upon by the municipal bodies were left to administrative officers, appointed not by the administrative body but by a mayor himself chosen directly by the people, would there be anything like as much danger of maladministration in the interests of councilmen engaged in building trades as is evidenced by the case cited above? Clearly, it seems to us, there would not, although in the last analysis we find that all questions of this sort come back upon the intelligence and forcefulness of public opinion. Yet there can be no question but what machinery well designed for the work it has to do can turn out a better product than that which is poorly designed and which is not under control.

Control is an essential and overlooked factor in efficient municipal administration. Some one must be held clearly responsible for every official act, and it is difficult to make the responsibility stand out clearly when two entirely different functions, like legislation and administration, are imposed upon one set of men.

Finally, we think this incident as a whole tends to confirm the growing American practice of separating as completely as possible the administrative and legislative departments of our cities.

LETTERS TO THE EDITOR.

Standard Methods of Bacterial Water Analysis.

Sir: In your issue of April 22, 1909, there appeared a query as to the proper methods of conducting bacterial analyses for control of filter plants, following which query your correspondent was referred to the report of the Committee on Standard Methods of Water Analyses. The point at issue was particularly the significance of the differences in bacterial counts obtained with different periods of incubation. This letter was followed on May 13 with a brief statement by the writer, indicating some of his experiences with different periods of incubation, particularly at different seasons of the year. Briefly, the writer endeavored to show that a higher efficiency is apparently obtained by a filter plant when gelatin is used as a medium for growing bacterial counts than when agar is used; also that a higher efficiency is obtained with a two days' period of incubation than with a three days' period.

In your issue of June 10, there is a further communication along these lines, from still another source, in which the writer states that these things have all been well known for a long time past in Massachusetts, where complete and final studies of the various methods of conducting bacterial tests have been made and published long ago. It is true that Massachusetts investigators have done much toward the advancement of sanitary engineering, but they have been frequently criticised, whether justly or not, on the ground of assuming that Massachusetts conditions cover the entire field of such work.

The difference between the foreign and American personnel in control of filter plants is cited in the latest of the letters. As there stated, this is a very important point in determining the results accomplished and the methods of analyses used by the various analysts in control of water plants. Comparison along similar lines might, however, be carried still further and a comparison be made between conditions that occur in New England and say in the Middle West. New England waters are so clear that they are best treated by slow sand filters which are simple in operation. Those in charge of such plants are properly analysts and men trained almost exclusively along biological lines. In the Middle West, however, conditions are very different. Here mechanical filtration plants are almost universally used and the mechanical filter with its necessary coagulating devices and basins, its controlling and cleaning devices, is a delicate machine and the operator must have a training considerably different from that of the slow sand filter attendant. On this account superintendents in charge of mechanical filter plants are frequently enlisted from the ranks of filter attendants who are familiar with the mechanical operation of the plant, but who are not technical men or bacteriologists. They are, however, when properly instructed, capable of making the few simple tests necessary to control the operation of their plants. Such men are constantly seeking information as to the proper methods of making bacterial tests and, unfortunately, there is at present no book to which they may be referred to learn the proper procedure. Take the simple matter of preparing agar media necessary for determining bacterial counts; in no case has the writer found an operator who could make satisfactory agar following the description of the procedure as given in the report of the Committee on Standard Methods.

The most important test made at a filter plant is for the presence of B. coli and no one now considers such tests of much value unless they are made to determine approximately the number of coli present in the raw water. This matter is not even touched upon in the committee's report. Nor are there given suggestions as to the number of cubic centimeters of filtered water that should be tested nor as to the significance of such results. Some authorities say that 1 c. c. is the quantity that should be used for tests and that if it is desired to test 10 c. c. then ten 1 c. c. portions should be used. The writer considers the absence of coli in 1 c. c. of filter water of little significance, but that at least 25 or 50 c. c. should always be used. English practice requires that not more than 50% of the 100 c. c. samples of filtered water should contain coli, but how many tests along these lines are made in this country? Bile is the medium in common use abroad to test for coli and is coming into more general use in this country; it is, however, not even recommended in the report of the committee.

The writer's previous statement of the effect of temperature on bacterial counts was apparently understood by our recent correspondent to refer to temperature of incubation; it was intended, however, to refer to the temperature of the raw water tested, as in the winter the bacterial counts are much retarded by the low original temperature of the water and the apparent devitalized condition of the bacteria.

In this letter the writer simply desires to call attention to the fact that a revised report, giving up-to-date methods for bacterial tests of water, is very much in demand at the present time. While it is true that men who make a special study of bacteriology can keep in touch with the work accomplished from time to time by other analysts, and thus learn improved methods of testing, this is not possible nor reasonable to expect of the men frequently in charge of filter plants. Water purification plants are increasing in number more rapidly than are the trained operators capable of taking immediate charge of them, and such plants are frequently placed under non-technical men who have to obtain the information required for proper tests as best they can.

Philip Burgess,
Asst. Engr., Ohio State Board of Health.
Columbus, Ohio, June 15, 1909.

A Primitive Bridge With Cantilever-and-Suspension Combination.

Sir: I am enclosing a photograph and under separate cover sending a sketch [both reproduced herewith—Ed.] of an Indian-built bridge situated about 200 miles east of Prince Rupert, B. C., near the proposed line of the

FIG. 1. PRIMITIVE BRIDGE OVER BULKLEY RIVER, IN BRITISH COLUMBIA; SAID TO HAVE BEEN BUILT BY INDIANS.

Grand Trunk Pacific Ry., which I thought might be of interest. The bridge is built of round poles fastened together with telegraph wire and wooden pins, the floor being the only part where nails are used to any extent. My rough sketch shows the location and relation of the different members, without detail, as no two joints are made alike. It seems to do the work required of it, that is as a means for pack trains to cross the Bulkley River. I couldn't find out just when it was built, but from its appearance would say it had been there more than ten years.

Looking at it from a distance it seems to be nothing but a collection of poles and wire stuck together any way, with no particular reason for its not falling; the floor is very uneven, and the joints of the different members are made by lapping and binding them with wire. But by looking at it closely a person can see that the party who built it had a pretty good idea of what the different members were for and what work they would do.

Yours truly,
W. D. Holt,
Res. S, G. T. P. Ry.
Hole-in-the-Wall, B. C., May 30, 1909.

Rates of Pay for Subordinate Engineering Assistants.

Sir: Referring to the much discussed "Technical League": Have the promoters of this institution considered that there may (and will most probably) be a demand for the services of many of its members at some rate of pay but no demand for them at a higher rate?

In the past year the writer has employed many young men as rodmen and chainmen. At first uneducated men were employed. Later, it developed that graduates in engineering without experience would gladly accept these places for the same compensation that the uneducated men were receiving. The latter are being dropped from our ranks and their places filled with college men.

If the Technical League advances the price for the services of these inexperienced young fellows, who are anxious for a start where they can acquire practical experience, many of them may have a wait much more long and irksome than under present conditions, because the position of chainman can be filled by an intelligent laborer, and does not justify union wages.

Very truly yours,
A. L. Dabney.
Clarksdale, Miss., June 14, 1909.

Expansion Allowance at Rail Joints.

Sir: In our present railway track, the manner and matter of expansion allowance at the joints has been given a great amount of thought and study, but there is one thing in connection with our present joints about which I would like to hear from some of your readers. That is, why do most of our railways allow in the angle bar and bolt holes almost double the expansion necessary?

According to the American Railway Engineering and Maintenance of Way Association a 33-ft. rail has a maximum expansion of 5/8-in. The average standard rail joint allows 1/4-in. in the bolt holes in each rail, and an allowance of from 1/8-in. to 1/4-in. in the angle bar, making (assuming that all bolts, rail and angle bars are new and not worn) an expansion allowance in each joint of from 5/8-in. to 3/4-in. This allows the rail to pull open from 1/4-in. to 3/8-in. more than is necessary at the joint that will slide the easiest, and as the rail and fastenings become worn a 1-in. opening is often found. This not only causes the rail to batter on the ends, but makes the cost of maintainance much greater than it would be if the joint were made so that only the extreme expansion of the rail could be secured.

In my experience I call to mind 6½ miles of track, out of which I had driven expansion to the amount of over 32 ft. on one side, and almost that amount on the other side. Previous to this driving out of the expansion, this track was always rough, besides being very expensive to keep in even a passably fair condition. After driving, this track was maintained at an average cost and condition of the balance of track. This unnecessary expansion is very expensive to railway companies and should be eliminated.

Another instance is where some four miles of old track, level grade, was laid so that there was double the expansion necessary. It was ballasted with cinders, shouldered 16 ins. outside of the ties. This track buckled, lifted itself out of the ballast in places, and kinked by the extreme heat, to such an extent that trains could not pass over it for several hours. This was caused by the angle bars becoming bent from the heavy hammer at the open joints, to such an extent that the rail would not run in the bars.

A. Q. Campbell,
Asst. Engr., Southern Pacific Ry.
Ogden, Utah, June 5, 1909.

[The "Manual of Recommended Practice" of the American Railway Engineering and Maintenance of Way Association gives the expansion spacing for 33-ft. rails as 1/16-in. at 100° to 75° (close spacing above 100°), and 5/16-in. at 0° to — 20°. Unnecessarily wide spacing at the joints makes a rough riding track and entails increased work and cost for maintenance and renewals.

One reason for the large allowance in bolt holes has been the impracticability of neat fits or close work in track maintenance with rough bolts and punched holes. With hundreds of consecutive rail joints in which the bolts have been tightened or renewed from time to time, and which have been subjected to traffic and temperature conditions, to say nothing of numerous rail renewals, it is impossible to reckon upon the theoretical expansion at each joint. In such a track, the position of the bolts in the holes is likely to be very irregular. Tight bolts, bent splice bars or other causes may tend to grip the rails at certain points. The spacing has undoubtedly been very largely a rule of thumb, but on many railways a much closer fit is given now than in earlier days. Some examples of modern practice are tabulated below.—Ed.]

	C. & N. W. Ry.	N. Y. Cen. Ry.	B. & O. Ry.
	ins.	ins.	ins.
Bolt	13/16	3/4	7/8
Hole in rail...	7/8	1	1 1/16
Hole in bar....	1 1/16	7/8	1
Bolt neck.....	13/16 × 1 1/8	7/8 sq.	7/8 × 1 1/4*
Hole in bar...	15/16 × 1 5/16	1 1/16 sq.	15/16 × 1 9/16 / 1 × 1 9/16

*Tapering bolt neck.

Actual and Estimated Weights of the Blackwell's Island Bridge Superstructure.

Sir: In the 3d conclusion of the Commission of Engineers who reviewed the report of Mr. F. C. Kunz on the Blackwell's Island Bridge, published in your issue of June 17, it is stated:

The actual weight of the steel superstructure practically agrees with the estimated weight used in calculating the stresses, within the usual allowance permitted in bridge work.

Mr. Kunz states that the original estimate of the weight of steel was 86,000,000 lbs. The actual shipping weight was 105,150,000 lbs. This is an increase of over 22%. Is this "within the usual allowance permitted in bridge work"?

I have been unable to discover from the report of Mr. Kunz, whether any of the members of this bridge were fabricated according to details based on computations from the original 86,000,000-lb. dead load assumption, or whether 95,000,000 lbs. was used or 100,750,000 lbs., to revise the stresses before any fabrication was begun; but it seems to me, and I think most bridge engineers will agree with me, that a 22% increase in dead load would more than justify—would in fact make essential—a revision of stresses before starting any shopwork at all.

It should be recognized in the future that in bridges of such magnitude, especially when without precedent, complete details should be made, weights figured and original dead-load stresses revised if necessary, and the process repeated if the difference is too great, before any of the work is put in the shops.

Yours truly,
June 19, 1909. "Engineer."

[Mr. Kunz's report, if we read it right, says that the Island Span was *designed and fabricated* on the basis of the intermediate assumption of 95,000,000 lbs. steel weight. He says:

Beginning early in 1904, the Department ordered changes, * * * all this increasing the steel weight to about 95,000,000 lbs., with a total dead-load of 116,000,000 lbs. New dead-load stress sheets were made * * * (and) the sections of the truss members determined. * * * Shop drawings for the Island Span were now made by the contractor and approved by the Department with changes, *and the material ordered.*

In the meantime, new dead-load concentrations and new stress sheets were worked out. * * * As far as possible, the old stress and section sheets were then revised. *To change the material for the Island Span, at that time in the process of manufacture in the bridge shop, was impossible.* * * * The actual shipping weight of the bridge proper is about 105,150,000 lbs. * * *, giving a total dead-load of 125,680,000 lbs. * * * In the meantime the Department changed the plans for the paving * * * increasing the total dead-load to 132,300,000 lbs.

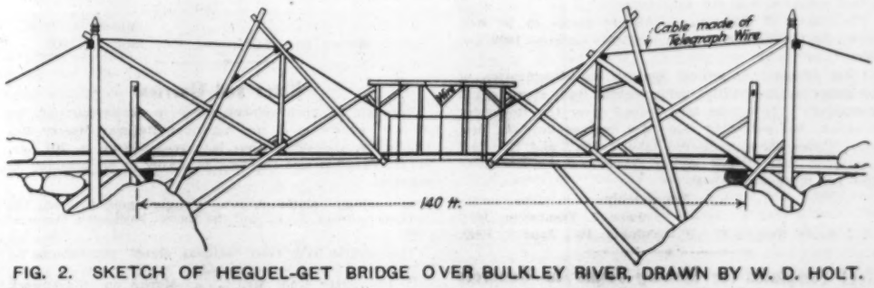


FIG. 2. SKETCH OF HEGUEL-GET BRIDGE OVER BULKLEY RIVER, DRAWN BY W. D. HOLT.

On the other hand Messrs. Macdonald, Schneider, Greiner and Leonard must have had different figures before them. They say:

The weight of steel now in place, plus an estimated weight of the additional steel required to complete the overhanging footwalks, amounts to 106,650,000 lbs. The same items were assumed, in the calculations of 1904, at 103,100,000 lbs. The assumptions as to these items were therefore exceeded but 3½%. * * * The total dead weight * * * would then be about 130,700,000 lbs. against an assumed (1904) weight of about 122,130,000 lbs.—an increase of 6½%. The dead-load stresses, however, are not increased to the above extent.

As these figures differ from those given by Mr. Kunz, we omitted them and said in our abstract: "There are some discrepancies between the Commission's figures for dead-load and those of Mr. Kunz." The discrepancies find no explanation in either of the reports.

Using our best judgment upon these discordant figures, we conclude that:

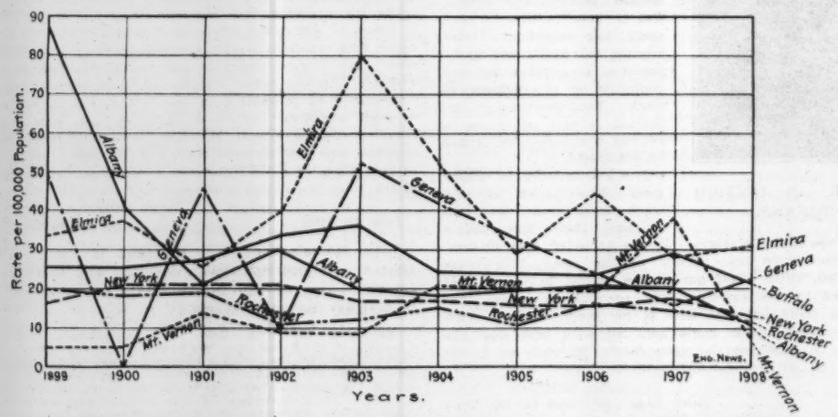
(1) The Island Span was proportioned for a dead-load at least 12% too low. If the dead-load were increased over the whole length of the bridge by this 12%, the dead-load stresses in the Island Span would be that much in excess. But as the weight of the Island Span was not increased, so that the relieving action of its own weight was not increased in proportion to the larger external bending moment, these dead-load stresses were doubtless increased more than 12%.

(2) The other spans were designed for a dead-load about 6 or 7% too low.

We agree with the writer of the above letter that such a case emphatically calls for redesign until the assumed and actual dead weights are in agreement. Practically the same state of affairs as above exhibited prevailed in the design of the Quebec Bridge, and was sharply criticized after the fall of that structure.—Ed.]

Typhoid Fever in Some of the Principal Cities of New York State.

Sir: Noting Table I., typhoid fever mortality for the past ten years in the cities of New York State, taken from the March Bulletin of the New York State Department of Health, and published in Engineering News, May 27, 1909, page 580, I enclose plotting of the results for some of the principal cities and towns.



TYPHOID FEVER MORTALITY IN SOME CITIES OF THE STATE OF NEW YORK.

I note, with some surprise, the very low rate for New York City, notwithstanding its unfiltered Croton supply, a fact speaking well for subsidence.

The effect of filtration at Albany seems to be well shown by the sudden drop in its curve between 1899 and 1901.

I am disposed to protest against the classification of Rochester among "Cities using waters from streams and reservoirs." This title does indeed cover the Rochester situation, but evidently this class merges into the first one, "Cities using unfiltered lake water," and this last mentioned title strikes me as describing the Rochester case far more accurately.

Yours truly,
John C. Trautwine, Jr.

237 South Fourth St., Philadelphia, Pa., June 5, 1909.

Steel Templates for Making Joints in Concrete Sidewalks and Curbs.

Sir: A letter in your issue of June 3 described the use of steel templates in making joints in concrete sidewalks at Louisville, Ky., and spoke of it as an innovation. Similar templates have been used at Fort Riley for several years and have been unfailing in preventing cracks in the finished walk. We require such a joint every 6 ft. and also wherever the concrete changes in thickness, as at a step. Steel templates are also used on our concrete curb and gutter. Lately we had an illustration of the advantages of a clean, open joint when we successfully lowered half a dozen sections of curb and gutter around a curve where the original grade was not enough to carry the water.

The steel template, besides its advantages in giving a good joint, makes a much better working level than wooden forms, and enables one to get a smoother and more even grade with less trouble.

Yours truly,
C. R. Mandigo,
Civil Eng. and Supt. Const.

Fort Riley, Kansas, June 12, 1909.

The McCall Ferry Power Plant.

Sir: Referring to the comments of Mr. Cary T. Hutchinson on my article on "The Susquehanna River as a Source of Power (Eng. News, June 10, 1909, p. 625), a careful reader will discover no material discrepancies between my statements and his except that I gave the McCall Ferry power plant credit for twice as much pondage as he has. In either case, the reserve capacity of the pond is so small that it has no practical value other than as a balance for hourly fluctuations in the long periods of extreme low water, which it has been shown, occur on an average of once every four years. I made no attempt to analyze the daily capacity of a plant on the Susquehanna as affected by its load factor, but simply to show the total energy available. While it is true, as he states, the McCall Ferry plant can deliver on the line 400,000-KW. hours in addition to the stream flow by drawing down its pond 5 ft., at the same time I would hesitate to say what might happen to the plant operator who did this at a time of low water when the plant would be required to deliver the full amount of energy of the stream flow as its daily average, for it would require two days to refill the pond if during that time the plant did not turn a wheel.

There was no spirit of criticism of the McCall Ferry plant or any other intended in my article. On the other hand, the manner in which this development has been planned and is being carried out can only excite admiration among engineers. The time is rapidly approaching when we will be largely dependent on flowing streams for power. The only regret is that the rapid development and increasing value of property along our rivers is making the cost of complete power development almost prohibitive. It is this fact alone I presume which accounts for the McCall Ferry plant not having 75 or 100 ft. head instead of 53 ft.

Yours truly,
Mason D. Pratt.

16 S. Market Sq., Harrisburg, Pa., June 14, 1909.

Notes and Queries.

Through a typographical error in the report of the annual convention of the American Railway Master Mechanics' Association in our last week's issue, p. 701, Mr. H. H. Vaughan was reported as saying in his presidential address

that a closer relationship be brought about between the various railway *clerks* and the Master Mechanics' Association.

This should have read "railway clubs" not "clerks."

In the letter from Mr. E. A. Moritz on "Earthwork Diagram for Estimating Quantities in Small Irrigation Canals in Level Section" in our issue of June 10, 1909, p. 634, the following errors should be noted:

In Fig. 2 "$d + h = 3$" should read "$d + h = 2$," and in the ninth line from the bottom of the third column on p. 634 "$C = 2$" should read "$C_1 = 2$." The horizontal lines in the diagram Fig. 3 should have been run clear across the diagram.

Time Tests of Preservative Coatings on Steel Cars.*

Your committee has examined a number of old and steel 100,000-lb. capacity cars under test and in ordinary service, and the results of the various tests are as follows:

One car, thoroughly dry cleaned and given two coats of a special black paint, was then coated over with crude petroleum oil. After 15 months' service it was found that the painted surface of the car was in fine condition and there is a showing of the crude oil still clinging to the paint surface.

One car, thoroughly dry cleaned and given two coats of a special black paint, was then coated over with locomotive cylinder oil. After 15 months' service it was found that the painted surface of the car was in fair condition. We are inclined to believe that the application of the locomotive cylinder oil had a tendency to extend the elastic life of the paint.

One car, thoroughly dry cleaned and given two coats of a special black paint, was then coated over with a good quality of fish oil, applied with brush. After being in service 15 months the condition of the paint was very fine indeed, but there was no indication of the surface oil at time of inspection.

One car, thoroughly dry cleaned and given two coats of common red car paint generally used by railroads, was then covered with equal parts of raw linseed oil and pure glycerine. After being in service 15 months it proved to be the slowest in drying. The painted surface was in good condition.

One car, thoroughly dry cleaned and painted with two coats of common red car paint generally used by railroads, was then given a coating of "Cleanola." After being in service 15 months the paint was found to be in fair condition. It also shows some preservation.

One car, thoroughly dry cleaned and given two coats of common red car paint generally used by railroads, was then covered with a coat of well-rubbed-in commercial tallow. After this car had been in service 15 months the paint was found to be in fair condition, but no traces of the overcoat of tallow remains.

One car was thoroughly dry cleaned and covered with two coats of a special black paint. (No preservative applied.) After being in service 8 months the paint was found in remarkably good condition, notwithstanding the fact that there appears to be much material brittleness, also loss of weight in scrapings.

One car, thoroughly dry cleaned and given two coats of a special black paint, was then covered with a special manufactured over oil. After being in service 8 months the paint was found to be broken in places, and the scrapings appear to be soft, broken and tacky.

Six cars were thoroughly cleaned out on the inside and with an atomizing machine were given two coats of crude petroleum oil. After being in service 15 months the interior was examined. To the eye and touch these surfaces did not give the slightest indication of the previous bountiful oil coating. Our inspection convinced us that if this treatment acts as a preservative in any form the insides should be treated at least every 6 months.

Your committee at the present time has under test 25 steel cars which have had the insides sand-blasted and the seven following mixtures applied heavily and not brushed out:

	Lbs.
No. 1.	
Petrolatum	30
Raw linseed oil	210
No. 2.	
Petrolatum	30
Corn oil	210
No. 3.	
Petrolatum	30
Crude oil	210
No. 4.	
Tar	30
Aniline oil	40
Corn oil	170
No. 5.	
Tar	30
Aniline oil	40
Raw linseed oil	170
No. 6.	
Tar	30
Aniline oil	40
Portland cement	30
Corn oil	140
No. 7.	
Tar	30
Aniline oil	40
Portland cement	30
Raw linseed oil	140

Three cars received mixture No. 1; three cars No. 2; three cars No. 3; three cars No. 4; four cars No. 5; four cars No. 6, and five cars No. 7.

Two cars bearing mixture No. 1 were examined after being in service 4 months and 29 days and found to have sides and ends in fair condition, but paint was gone from the bottom and no scale accumulated on the inside of car.

One car bearing mixture No. 2 was examined after be-

*Portion of Report of Committee on Painting Steel Cars, presented to the Master Car Builders' Association at the annual convention, Atlantic City, N. J., June 21-23, 1909.

ing in service 4 months and 26 days and found to have sides and ends fairly well preserved, but paint gone from the bottom and no accumulation of rust.

Two cars bearing mixture No. 3 were examined after being in service 4 months and 21 days and show the sides and ends somewhat protected, but considerable rusting going on. This mixture did not retard rusting as well as mixtures Nos. 1 and 2.

One car bearing mixture No. 4 was examined after being in service 4 months and 17 days and shows the inside well preserved, but considerable of the paint gone from the bottom, yet there seemed to be retardation of the rusting and no accumulation of scale. This mixture shows better results than mixtures Nos. 1, 2 and 3.

One car bearing mixture No. 7 was examined after being in service 4 months and shows sides well preserved, but bottom somewhat rusted. This car was in a better condition than any of the other cars inspected and would indicate that No. 7 mixture is preferable and would be especially valuable from the tests so far made. To get the best results from a coating of this kind, one coat should be applied about once every 6 or 8 months.

However, it is not fair for us to draw a conclusion as to which of these inside mixtures is the best, for the reason that the cars have not been in service long enough to determine this feature. Until these inside mixtures are thoroughly tested out your committee is not in a position to recommend their use, but is anxious to learn the outcome of the experiment.

We also realize that it will be less difficult to secure a serviceable outside paint than to find an inside preservative.

Your committee also realizes the necessity of a continuation for another year in order to further determine the results of the tests now being made.

Annual Meeting of the Society for the Promotion of Engineering Education.

The seventeenth annual meeting of the Society for the Promotion of Engineering Education was held at Columbia University, New York City, and Pratt Institute, Brooklyn, from June 24 to 26.

The reports of the treasurer, Mr. William O. Wiley, and of the secretary, Prof. Arthur S. Williston, indicated a steady growth of the society. There are sufficient funds in the treasury to defray the cost of last year's Proceedings (not yet published), and some $500 of dues are still unpaid. The present membership numbers 750, an increase of 335 within the last three years.

The Committee on Technical Books for Libraries (Prof. Arthur H. Ford, of the State University of Iowa, Chairman) presented its report in printed form for distribution. The report received severe criticism and was finally referred back to the committee for revision.

The Committee on the Teaching of Mathematics to Engineering Students presented a progress report through its chairman, Prof. E. V. Huntington, of Harvard. The committee gave a resumé of the proceedings of a conference between engineers and teachers of mathematics, held at Chicago in December last. The general purport of opinion was that mathematics should be taught with great care that the student obtains a clear understanding of the methods pursued and the meaning of the work he is doing. Too many students learn their mathematics by rote.

At the evening session held at Columbia, the president of the society, Dean Frederick E. Turneaure, of the University of Wisconsin, presented the annual address. The subject was "Present Tendencies in Technical Education," and a keen and thorough discussion was given. Extracts from the address are printed on another page of this issue. The closing paper of the evening was by Logan W. Page, Director of the Office of Public Roads of the U. S. Department of Agriculture. The paper was a plea for the teaching of highway engineering in the engineering schools. Mr. Page said that the courses now given on this subject in schools are insufficient, and that there is an urgent demand for competent highway engineers.

The Friday morning session was held at Pratt Institute, in Brooklyn. Mr. Frederic Pratt, Managing Secretary of the institute, in welcoming the society, gave a brief sketch of the early history of Pratt Institute and its founder, Mr. Charles Pratt, and explained something of the spirit in which its work is carried on.

Mr. Chas. B. Going, Editor of the "Engineering Magazine," then read a paper entitled "The Relation of Engineering Education to Industries." In this paper, he asserted that the prevalence of the idea that graduates of technical schools are too theoretical seems to indicate some deficiency in present educational methods and to show that subjects are not taught as they must be practiced. What is taught, he said, is not so important as how it is taught. Influences which tend to make the professors of engineering more and more academic, the jealousy of universities which prevent them from keeping in touch with the practical side of their subjects, and a tendency to cling to traditions are the causes for the defects mentioned. The economical or industrial aspects of engineering are not accorded due consideration. Even the shop practice at technical schools, said Mr. Going, is not of the right sort and tends to produce "scientists in overalls," so that the students invade a trade at one end and a pure science at the other. What is needed is a less grudging acknowledgment of the importance of economical operation, a closer association of the faculty with outside practice and a closer conformity of the student's college work to his later activities.

In the discussion, Mr. Frederick W. Taylor spoke from the viewpoint of the employer of technical school graduates, of whom he has trained several hundred. His criticism was chiefly directed toward certain features in the present day training of engineers. From his experience he would select an engineering graduate to fill an important industrial position, yet he recognized the defects in the men as they are turned out of the schools.

Teachers in engineering schools are not conversant with the attitude of employers toward engineering graduates. The great majority of employers want nothing to do with young engineers if they can help it. Those who have had the most to do with them want more men, but hate to break them in. Nine out of ten technical graduates are dissatisfied and unhappy for at least one or two years after graduation, and likewise are unsatisfactory and bothersome to their employers. This is an unnecessary condition of affairs.

It is caused by two things. First is the fact that during the college course students are subjected to less discipline and have greater personal freedom than ever before or after. The college man gets it into his head that a reasonable excuse is as good as a result; but an employer has no use for an excuse, reasonable or otherwise. The second cause is that the engineering graduate has been allowed to go for about 22 years without even a single look at conditions he must suddenly face after graduation. He has been all his life absorbing things for his own mind and use and must now begin giving out results to help others. Intellectual training receives almost the sole attention in college, but for the attainment of success in life it is subordinate both to character and to common sense. Character training is scandalously neglected at colleges, where it is only required that the student keep out of jail.

As a palliative for these evils, Mr. Taylor suggested that each student be required to leave college at the end of his freshmen year and work for one year in a shop under actual industrial conditions. He considered a year's apprenticeship of more educational value than a year of travel abroad.

A record of the careers of graduates of Stevens Institute shows that more than one-half are engaged not in engineering but in executive work. In view of this condition in the case of a representative school, time should be given not only to the study of structural materials but of the great raw material with which all work is done, that is, to the study of men. The investigation of Professor Furman, of Stevens Institute, shows that an apprenticeship of one to two years has stamped itself as the surest road to eminent success in after life.

Mr. Taylor's paper was followed by a general discussion of the ideas advanced by him and by Mr. Going. The general sentiment seemed to be that, while some of the criticisms of present educational methods might be true, it was better to allow time for the natural development of changes in the technical school than to attempt the sudden introduction of revolutionary changes.

Lantern slides were then presented showing some of the laboratories and methods of teaching at Pratt Institute, after which the members made an inspection of the shops and chemical laboratory, concluding the morning's session with luncheon served in the chemical building.

At the session on Friday afternoon, held in the Engineering Societies Building, Professor Louis E. Reber, of the University of Wisconsin, described the correspondence instruction which that institution is now carrying on. There are now some 2,000 students enrolled in the courses and about 50 instructors. About $70,000 a year is now being expended on this department.

Two papers and a discussion on the extension of engineering courses to five or six years followed, the papers being by Prof. Charles Derleth, of the University of California, and Prof. Robert Fletcher, of Dartmouth. It appears that a very considerable number of institutions are now giving or are about establishing five or six-year courses in engineering. These longer courses give more time for culture studies, enable the entrance requirements to be relaxed, so that some of the work done heretofore in the preparatory schools can be done in the college and in a more thorough manner, and permit advanced instruction in various branches of engineering to be undertaken.

Prof. Hugo Diemer, of Pennsylvania State College, gave a paper describing results of a circular letter of inquiry to employees of mechanical engineering graduates inquiring what were the weak points in such men for the positions for which they were engaged.

The discussion of five-year and six-year courses was resumed at the final session on Saturday morning, and occupied a large part of the forenoon. Prof. Constant, of the University of Minnesota, said that beginning with the freshman class which entered in 1908 nothing but a five-year course is being offered at that institution. The enrollment fell off but little with the first five-year course class. It is thought that the broader and more humanitarian character of the five-year course will attract students who would shun the narrower four-year course. As much as possible of the technical work is reserved for the fifth year. Those who leave at the end of the fourth year will have a broader training for engineering work than members of the earlier four-year course, and will be given the degree of B. S. E.

At the University of Iowa, another speaker said, the same general five-year course as Prof. Constant outlined is given, but the degree of B. S. instead of B. S. E. is awarded at the end of four years. Still another speaker stated that a five-year course would be instituted at the University of Missouri in 1911, but no degree whatever will be granted unless the full course of five years is taken. Prof. French suggested that a B. S. degree be granted at the end of three years, thus helping to weed out men who are fit for only minor positions.

Prest. A. C. Humphreys, of Stevens Institute, having been called upon expressed himself very strongly in favor of sticking to the four-year course. Four years of study confined rather closely to fundamentals does very well and is as long as the students should be kept from the school of practical experience.

Prof. Geo. F. Swain, recently of the Massachusetts Institute of Technology and now of the new graduate engineering school at Harvard, disagreed entirely with Prest. Humphrey. He urged that engineering has changed greatly in the last 40 years, and that there is so much more to be learned now than then that longer periods of study are needed. The object of technical education, he added, is not merely to make a man an engineer; besides that, he should be made broadly useful to the world.

Interesting tabular and graphical summaries of the positions held and salaries received by the

engineering graduates of the University of Michigan were presented by Dean M. E. Cooley, of that institution. The studies as to occupations were based on records of 1,230 graduates, as published in a bulletin of the society which is available to any one who requests a copy. The classification was by 38 occupations. The number of graduates in some of the leading occupations, numbers alone considered, was as follows: civil engineers, 183; draftsmen, 127; superintendents, 111; managers, 81; electrical engineers, 69; chief engineers, 64; mechanical engineers, 60.

By five-year groups, responsible positions are held by 94% of the graduates of 1878-82, and by 93, 84, 65, 52 and 24%, respectively, of the graduates of each succeeding five-year period.

The earning-capacity summaries presented by Dean Cooley were based on special enquiries sent to all recorded living graduates, of whom 75 to 80% replied. Graduates prior to 1887, or men 20 years out of college, reported an average salary of $5,584, besides an average income of $7,301 from other sources. The average salary for the 20 years since 1887 has ranged from $4,100 or $4,200 to some $2,300 or $2,400; depending on the length of time out of college.

A number of other papers and reports were read or presented by title during the convention, for which reference must be had to the annual proceedings.

Mr. Henry S. Munroe, Professor of Mining Engineering at Columbia University, was chosen President for the ensuing year, and Mr. H. H. Norris, Professor of Electrical Engineering at Cornell University, was elected Secretary. About 90 new members were elected during the convention. The total registration for this meeting was reported at about 125, which was said to be well above any previous attendance.

Crushing Tests on Water-Soaked Timbers.

By EDWARD C. SHERMAN,* Assoc. M. Am. Soc. C. E.

The preliminary designs for the lock in the Charles River Dam in Boston, Mass. (Engineering News, July 9, 1908, p. 27), showed the tracks for the rolling caisson lock gates resting upon longitudinal timbers embedded in the concrete floor of the lock. Before final details were prepared it was questioned whether permanently submerged timber would have sufficient transverse crushing strength to carry the weight of the enormously heavy gates, especially under certain conditions which might cause the whole weight of a gate to rest upon four wheels.

As little satisfactory data was available for the solution of the question, sections of the wales of the cofferdam about the lock, which had been submerged in the brackish water of the river basin for about two years, were cut out and a series of tests made upon them to determine to what extent they might be depended upon to resist crushing.

The first tests showed an apparent yield point at such low unit stresses and with such noticeable bulging of the sides that the writer suggested that better results might be obtained if the material were held from bulging by steel plates and bolts. Other tests were then made with such reinforcement as shown by the diagrams, but even with their help the timbers appeared to be very pliable.

No attempt was made to deduce any formulas for the strength of the materials experimented with, but the results of the tests indicated clearly that neither long-leaf yellow pine nor oak, after being submerged for a few years, would be capable of supporting the gates and the plans were changed to show cast-iron chairs for the rails.

The tests were made under the writer's direction by Prof. C. E. Fuller, of the Mechanical Engineering Department at the Massachusetts Institute of Technology, the 300,000-lb. Emery testing machine being used. The accompanying figures give the curves for the tests grouped according to the kind of timber tested. Each block was tested by pressure applied across the grain in the direction of the arrows shown. Up to a point of serious yielding compression was measured to the nearest 0.01 in. by means of dividers and a scale; after that the measurement was made to the nearest 1/16-in. by a scale. On the diagram the abscissas represent proportional compression.

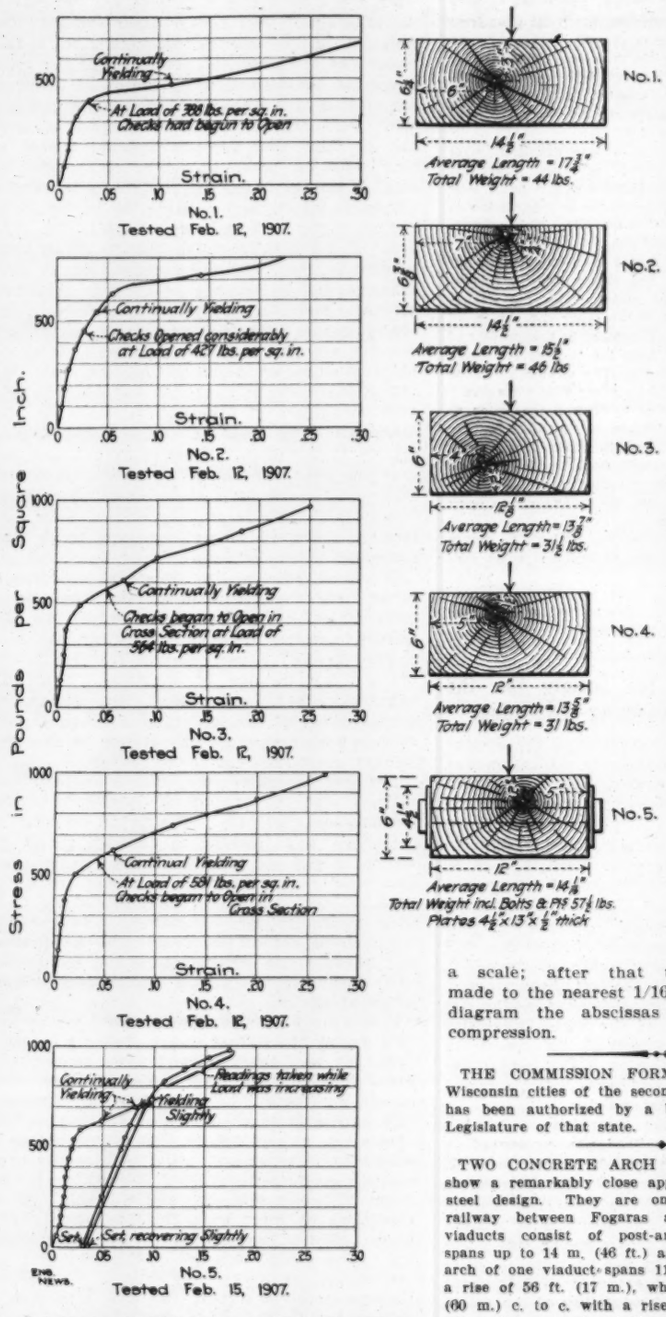


Fig. 1. Tests of Water-Soaked Yellow-Pine Blocks

(All specimens cut from lower outside waling of cofferdam at lock and had been in salt water for two years.)

Piece No. 5 is from the same stick as Nos. 3 and 4, the stick having been kept in the laboratory 4 days. Two plates each bolted to the block with 1-in. bolts driven through 1-in. holes in timber. The nuts were set up with an estimated pull of 150 lbs. on end of a 12-in. wrench.

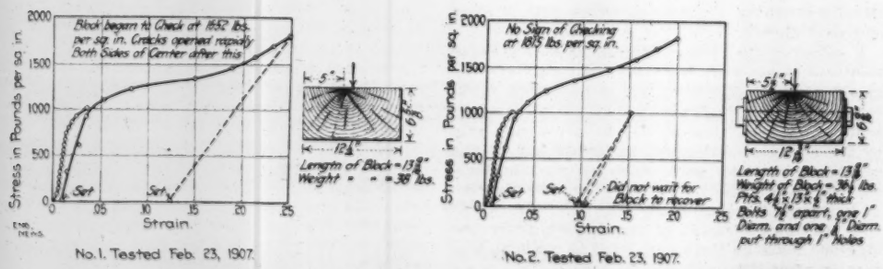

Block began to Check at 1852 lbs. per sq. in. Cracks opened rapidly Both Sides of Center after this
Set
Set
Strain.
Stress in Pounds per sq. in.
No. 1. Tested Feb. 23, 1907.
No Sign of Checking at 1815 lbs. per sq. in.
Set
Set
Did not wait for Block to recover
Strain.
Stress in Pounds per sq. in.
No. 2. Tested Feb. 23, 1907.

FIG. 2. TESTS OF WATER-SOAKED WESTERN OAK BLOCKS.

(Both blocks cut from same piece, which had been immersed in salt water one year. Tested wet.)

*Designing Engineer, Isthmian Canal Commission, Culebra, Canal Zone, formerly Division Engineer, Charles River Basin Commission, Boston, Mass.

THE COMMISSION FORM OF GOVERNMENT for Wisconsin cities of the second, third and fourth classes has been authorized by a bill which has passed the Legislature of that state.

TWO CONCRETE ARCH VIADUCTS IN HUNGARY show a remarkably close approximation to the lines of steel design. They are on a single-track secondary railway between Fogaras and Kronstadt. The two viaducts consist of post-and-girder approaches with spans up to 14 m. (46 ft.) and a large arch span. The arch of one viaduct spans 118 ft. (36 m.) c. to c. with a rise of 56 ft. (17 m.), while the other spans 197 ft. (60 m.) c. to c. with a rise of 70 ft. (21.4 m.). The two arches are quite similar. Each consists of two narrow rectangular ribs, of approximately parabolic center line, increasing in depth from crown to springing. Posts rising from these ribs carry transverse floorbeams between which are stringers and a slab floor. At the foot of every pair of posts the arch ribs are connected by a transverse strut. The arch ribs of the larger arch have the following dimensions: Width, 23.6 ins.; crown depth, 53 ins.; depth at springing, 126 ins. The ribs of the smaller arch have these dimensions: Width, 19.5 ins.; crown depth, 39.4 ins.; depth at springing, 74.8 ins. The maximum stress in the arch ribs is about 700 lbs. per sq. in., including temperature and braking stresses. The ribs are set on a batter of 1 in 10. Both viaducts are on a grade of 1.5%, and the alinement is partly on curve. The arch and its deck are straight, however, the track being at varying distances off center. The track is on ballast, and to hold this two low curb walls 9½ ft. apart are built on the deck, which is 10½ ft. wide over all. A special detail is the treatment of the expansion joint of the roadway over the skewback piers. Two separate bents of columns, 6½ ft. on centers, rise from this pier, one carrying the end of the viaduct girders, while the other carries the slab of the arch deck. The deck is cantilevered out beyond both bents a short distance, closing the gap except for a narrow expansion joint. The bridges were designed by Prof. Konstantin Zielinsky, of Budapest, and are described briefly (with views) in the "Schweizerische Bauzeitung" of May 29, 1909.

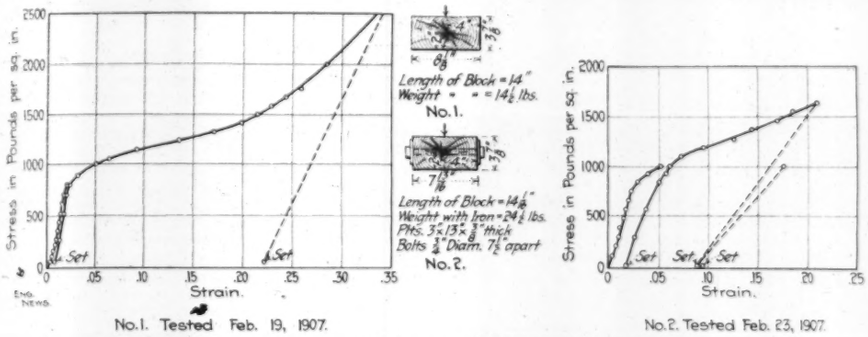
The History of Units of Land Measurement in England.*

By WILFRID AIRY, M. Inst. C. E.

The English system of land measurement has come down to us from the Romans, and their words "ager" = acre, and "Pertica" = perch still remain in our nomenclature. The "jugum" or "jugerum" of the Romans was defined in the same manner as our acre. Pliny says: "Jugum vocabatur, quod uno jugo boum in die exarari posset," which signifies "The jugum was the area of land which could be ploughed by a pair of oxen in one day."

In Andrews's Latin-English Lexicon it is stated that the Roman jugum was a rectangular area 80 yds. long by 40 yds. broad, or 3,200 sq. yds., whereas our acre is a rectangular area 220 yards long by 22 yards broad, or 4,840 sq. yds. Probably this great difference arises from the fact that the Romans in Italy used oxen for draft animals, while at the time when our acre was fixed we probably used horses. And it is likely that at the same time our ploughs were better made than theirs were formerly. The Latin word "Pertica," from which our word "perch" was derived, means a pole in its most general sense, and in its special signification was a measuring rod with which the grants of land were measured out to the soldiers. It has exactly the same meaning as our words "rod" and "pole."

The fundamental units of land measurement are the furlong and the acre. Both of these are natural units.



No. 1. Tested Feb. 19, 1907. No. 2. Tested Feb. 23, 1907.

FIG. 3. TESTS OF WATER-SOAKED WHITE OAK BLOCKS.

(Both blocks cut from same piece, which had been immersed in salt water one year. Tested wet.)

The furlong, or furrow-long, is the greatest length of straight furrow which a pair of draft animals can plough, when working advantageously. And the acre is the rectangular area of land, one side of which is the furlong, which the same animals can plough in a working day, when working advantageously. The perch is a derived unit, very convenient for measuring and setting out land areas: it is one-fourth of the other side of the rectangular area which contains the acre.

The reason why in advantageous ploughing the furrows should be as long as possible, provided always that the draft animals are not exhausted or distressed, is that when the furrows are short there are a great many of them to the acre, and a large proportion of the whole time is lost in turning the plough at the ends of the furrows. Thus, in "The Book of the Farm," by Henry Stephens, a table is given of the time lost when working with different lengths of furrow, from which it appears that in ploughing an acre on ridges of 78 yds. in length the time lost by turnings, in ploughing 10 hrs. with a 10-in. furrow-slice, is 5 hrs. 11 mins.; whereas, if the acre be ploughed with ridges of 212 yds. in length, the time lost by turnings is only 1 hr. 56½ mins. Therefore in this case the time saved by using the longer furrows is 3 hrs. 14½ mins.

It is easy to see from the definitions that both the furlong and the acre would vary very much under different conditions. The draft animals might be horses or oxen, the ploughs might be of rude construction or of improved construction, and the land might be heavy or light land. These and other conditions would affect the furlong and the acre very materially. And, therefore, for purposes of legislation, it was necessary to fix the conditions. In England, at any rate when the area and shape of the acre were fixed by statute, the draft animals were for the most part horses, and the land assumed would no doubt be good average corn land, such as would now be regarded as fairly heavy land. With these conditions it had no doubt been long established that the lengths of the furlong was about 220 yds., and that the width of the strip of land which could be ploughed in a fair working day was about 22 yds. As a convenient unit for measuring the land, as well as for setting out the headlands and ridges of the ploughing, a land-pole or perch having a length of one-fourth the width of the rectangular strip, or 5½ yds., was adopted. And the acre was then determined by statute to be a rectangular piece of land of such dimensions that it should contain exactly 160 square perches. The furlong was subsequently determined to be 40 perches in length, so that the width of the statute acre was 4 perches. And thus the primary or fundamental shape of the acre was a strip of land ten times as long as it is broad.

The earliest statute dealing with land measurement which has come down to us is the famous statute "De Admensuratione Terræ," 33 Edw. I., A. D., 1305. In this curious statute the acre is defined by its length and breadth in perches for 70 different proportions of length to breadth, the length changing by 1 perch at a time, and the corresponding breadth being given as computed, so that in every case the product of the length and breadth amounts to 160 square perches. And the length of the perch is defined to be 5½ yds. Thus the area of the acre is strictly defined by this statute. This statute appears to have been sufficient for many years, but it had at last become necessary to fix the shape as well as the size of the statute acre, and in a paper by Mr. Agard, dated November 24, 1599, it is stated as follows:

The table in the Star Chamber made in the 12th year of Henry VII. by sundry of the Council by Commission setteth down, that an acre should be XL pole in length and 4 pole in breadth; but how many feet the pole should contain it mentioneth not.

This was followed by the Act of Elizabeth Anno 35, cap. vi., which runs as follows:

"No new buildings shall be erected within three miles of London or Westminster. One dwelling house in London, Westminster, or three miles thereof, shall not be converted into more. No inmates or undersitters shall be in the place aforesaid. Commons or waste grounds, lying within three miles of London, shall not be enclosed. A mile shall contain eight furlongs, every furlong 40 poles, and every pole shall contain sixteen foot and an half."

This Act defines both the furlong and the mile. It had not been necessary to use the furlong as a unit for the definition of the acre; the derived unit, the perch, was sufficient for that purpose. But the furlong took its proper place as a natural unit of great importance when it was wanted as a stepping stone for the definition of the mile.

Although the size and shape of the statute acre were accurately defined by the Acts above quoted, yet there is abundant evidence that in most parts of England, for long after the date of the Acts and down to comparatively modern times, there existed local and customary values of the perch, and consequently of the acre (for the acre always contained 160 square perches), according to the nature of the land. Thus in "The Workes of Edmund Gunter" (1653), one of the problems which he deals with is: "Having the content of a superficies after one kind of perch, to find the content of the same superficies according to another kind of perch." In John, Worlidge's Mystery of Husbandry (1681),

"An Acre is one hundred and sixty square Lug, or Perch of Land, at sixteen foot and a half to the Perch; but of Coppice Wood eighteen foot to the Perch is the usual allowance. But an acre is sometimes estimated by the proportion of seed used on it; and so varies according to the richness or sterility of the land."

And in "The Schoolmaster's Assistant," by Thomas Dilworth (1764):

"Q. Is the Pole, or Perch, always of the same angle? A. No. Q. What is the difference? A. Five Yards and an half are the Statute-Measure for a Pole or Perch; but for Fens and Wood-lands it is customary to reckon 18 feet to the Pole; and for Forests 21 feet."

And in "The Complete Farmer: or A General Dictionary of Husbandry" (1769), we find, under the article "Acre," the following definition:

"Acre," a superficial measure of land, containing, according to the statute, one hundred and sixty square poles, or perches of sixteen foot and a half long. But this measure does not prevail in all parts of England: for though one hundred and sixty square poles or perches are allowed to be an acre, yet the length of the pole varies in different counties, and is generally called customary measure. Thus the customary perch in Staffordshire is 24 feet. In the forest of Sherwood 21. In Herefordshire the perch of walling is sixteen foot and a half; but a perch for digging twenty-one feet. Old farmers also estimate the acre of land by the proportion of seed used in sowing it; by which means it must vary in proportion to the fertility or barrenness of the soil; and hence in many counties of England they have two sorts of acres, distinguished by seed-acres and statute acres."

From this it would appear that rates, taxes, and other charges were levied upon the land at a uniform rate per acre. But since it would obviously be unfair to rate marshes and woodlands at the same figure per statute acre as good corn land, the acre was increased for the poorer land in such proportion that the incidence of the charges per acre should be the same all round. And this increase of the acre was effected by lengthening the perch for the poorer land, as above stated.

In early times, and probably down to the time of Edmund Gunter, whose first book was published in 1623, the only accurate method of measuring land was by means of a wooden rod or pole, cut to the length of the perch. The perch-pole would, no doubt, be subdivided by halves, quarters, eighths, and sixteenths, down to the thirty-secondths of the perch. And for the simple process of setting out and measuring rectangular land areas, this unit would be fairly convenient. But the perch is a short unit for land measurement, and the process would be rather slow. And for the measurement of fields of irregular shape the arithmetical reductions would become intolerably cumbrous and troublesome. It was necessary to seek for a more convenient unit, and the width of the statute acre—viz., 22 yds.—would naturally suggest itself for the purpose. But the adaptation of this unit of 22 yds., now known as the chain, was undoubtedly due to Gunter.

In his book, Ed. 1653, he gives a table for the use of the chain, composed of 100 links, which he called "Centesmes," and shows how this method of measurement would facilitate the computation of areas. One of his problems is: "Having the length and breadth of an oblong superficies given in chains, to find the content in acres;" and he proceeds to say.

"It being troublesome to divide the content in perches by 160, we may measure the length and breadth by chains, each chain being 4 perches in length and divided into 100 links, then will the work be more easie in Arithmetique."

Gunter, and no doubt others, had noticed that, by a happy accident, the length of the statute acre is ten times its width; if, therefore, the width be taken as a unit and be called a chain, the area evidently contains 10 square chains; and if the chain be divided into 100 links of equal length, the square chain would contain 10,000 square links, and the acre would contain 100,000 square links. And thus, by measuring in chains and "centesmes," or links, or decimals of a chain, the area result appears in acres and decimals of an acre. Nothing more simple than this could be devised, and nothing more has been needed for ordinary land measurement up to the present time.

The mile is a Roman measure. It was the *mille passuum* of the Romans, which is estimated at 1618 English yards, or 142 yards less than the English statute mile. It had long existed as a unit of length in England, though probably a very variable one, without any reference to the length of the other land measures. But it is a useful unit for road measurements, and its square is a useful unit for measuring the area of large districts, and when it became necessary to fix the relation that should exist between the various measures of the Kingdom, the English, with their natural predilection for the binary scale, found no difficulty in determining the length of the statute mile at 8 furlongs, or 1,760 yds., as defined in the Act of Elizabeth 35, cap. vi.

There seems to be no reason to doubt that, during the Roman occupation of Britain, the acre would be the unit of land measurement. But the Saxons evidently abolished the Roman system, and introduced their own measures for land, the principal one being the "hide" of land. The hide of land seems to have been the quantity of land, made up of proportions of arable, hay, and feeding land, which was sufficient for the maintenance of a man and his family. It commonly consisted of about 100 acres, but just as in the case of the acre in later times (as already mentioned), and for prabably the same reasons, the area of the hide varied very greatly in different parts of the country. There is an interesting note concerning the Saxon measurement of land in the paper already quoted by Mr. Agard, dated November 24, 1599, as follows:

"Yet the certainty of measuring of lands came not until the realm was under the tribute to the Danes, which was, as Walter Wifflesey, the monk of Peterborough, writeth, in the 30 year of King Æthelred, 'qui misit nuncios Danis, dicens quod vellet iis tributum dare, ut a rapinis desisterent, illi consenserunt, et dabatur iis tributum, quod est 36 millia librarum argenti': for the levying whereof the realm was admeasured, and the money levied per hidas. . . . And so in infinite places also, antequam terra hidate fuit, by which it appeareth that lands were first measured by hides."

The hide is frequently mentioned in Domesday Book and during the reigns of the early Norman Kings, but gradually fell into disuse, and had become obsolete by the time of Henry II. It is evident that the Normans had re-introduced the acre system of measurement, which, no doubt, they had brought with them from Normandy, and had abolished the hide.

*From "Engineering," London, March 12, 1909.

The Construction of a Concrete Mass and Blockwork Quay Wall by Helmet Divers in Open Water.*

By JOHN TAYLOR,† Assoc. M. Can Soc. C. E.

The quay wall which is described in this paper was built at Portland Harbor, England, in the years 1904-1906. It formed part of an extensive scheme of the British Admiralty to extend and increase the efficiency of the coaling facilities for the fleet at that port. Portland Naval Harbor, since the completion of the enclosing breakwaters, having been made the headquarters of both the Channel Fleet and a destroyer flotilla, and also an important rendezvous during speed and gun trials, manoeuvres, etc., the existing coaling accommodation and storage proved inadequate for modern requirements. To meet this change the work of which the wall herein described forms a part was constructed.

The outstanding features of the scheme were a deep-water wharf backed by coal storage grounds equipped with railroad tracks, coal-handling machinery and fuel oil plant. The writer proposes to confine the scope of this article simply to the quay wall which formed the wharf frontage of the work.

This wall, as will be seen from the cross-section shown in the accompanying figure, is built of Portland cement concrete masswork, faced with concrete blocks. The foundation of the wall up to 33½ ft. below low water level of spring tides is built of mass-concrete. Above this point the wall is faced with 8-ton blocks backed with masswork to the level of 2½ ft. above low water level. From this level to quay level the wall is finished of mass-concrete faced with a 12-in. layer of granolithic concrete. A coping of dressed Devonshire granite completes the wall.

This work was constructed within the comparatively sheltered area of the harbor. Portland Harbor, which is the largest artificial harbor in the world of its class, has an area of about 3,000 acres, with a deep water area of between 30 and 60 ft. deep at low water of about 2,000 acres. It is enclosed by three miles of breakwaters, which are provided with three entrances. These breakwaters enclose the Eastern Bay formed by the Island of Portland and its connecting link to the mainland, the Chesil Beach. Inside the harbor, the longest water fetch, tending to inconvenience the work, was only three miles, but considerable trouble was encountered from the heavy swell which entered the south entrance, which faces the open sea. Under unfavorable weather conditions this made it difficult to secure the temporary work and floating plant. On account of the depth of water and comparative exposure of the work, the more ordinary and easier methods of construction within cofferdams could not be taken advantage of. It is doubtful if a dam could have been made sufficiently strong to keep watertight and withstand the swell and the inevitable bumping from floating plant and passing craft, at anything like a reasonable cost.

It was therefore decided to build the work entirely in open water by the aid of helmet divers. The first work undertaken was, of course, the dredging of the foundation trench and the deepening of the berth in front of the wall. This work was done by the ladder dredge "Cornwall," a vessel owned by the contractors, and built to dredge to 50 ft. below her full load line. As the wall runs at an angle to the general shore line, guide signals could be set up on shore and lights fixed to guide the work at night. The dredged material was towed to sea in hopper barges with opening bottoms and deposited in deep water. The material proved easy for the ladder dredge to excavate, being mostly clay and mud, no large boulders or hard rock being encountered. The shale rock scaled off easily in layers with the ladder dredge, without blasting, but the grab had to be assisted by a diver occasionally to clear away some obstinate piece.

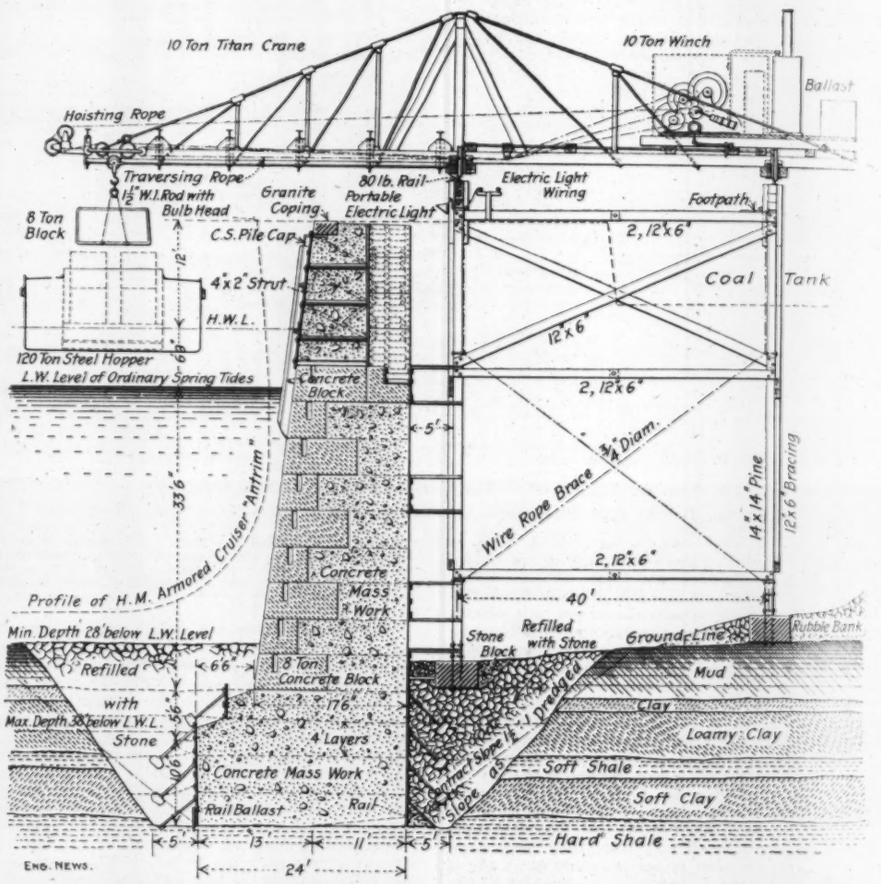
The foundation was dredged until the hard shale and a satisfactory foundation was reached, borings having been taken which established the presence of shale rock at a considerable depth below the mud line. The trench was excavated well clear of the back and front of the wall to provide room to work in and allow for the mud silting down the bank and filling up the angle at the bottom of the trench before concreting could commence. However, very little trouble was experienced from silting, the small amount which did find its way into the trench being easily removed by a grab immediately before the laying of the foundation concrete.

The water at this point, though often considerably agitated on the surface and for a few feet down, was practically motionless 30 ft. down, there being practically no currents of any kind to move the mud. The bottom of the foundation trench left by the dredge was found to be remarkably level, requiring no leveling by the divers before commencing on the concreting.

The concrete-mixing barges and the diving boats were moored along the line of the work to buoys securely attached to anchors and large stone blocks sunk in the mud.

The concrete forms for the quay wall was made in 20 × 4 ft. panels of 3-in. planking, strongly braced with 9 × 4½-in. stuff; ballast consisting of old rails being attached to the bottom of the panels on the outside in sufficient quantity to sink them into position. The panels were stored on a barge alongside the mixer and handled by the mixer cranes. They were set up in the foundation in parallel lines back and front of the wall and strutted on the outside with light rails and timbers.

Small buoys were attached by lines to the corners of each section to guide the craneman in depositing the concrete. In order to set out the line of the work a barge was securely moored over the work so as to practically eliminate movement, and the line was given by a transit from fixed points on shore. A 30-lb. plumb-bob, suspended by thin piano wire, was used to continue the line from the point on the barge down to the diver. This method proved to be quite satisfactory in ordinary weather. Afterwards, when the gantry was erected, line was given from the overhanging boom of the blocksetting cranes.



SECTION THROUGH CONCRETE WALL AT COALING WHARF, PORTLAND, ENG., HARBOR.
(Showing erection crane in place.)

In the lower part of the work the divers experienced some difficulty from the partial darkness in the foundation trench and the cement particles floating in the water which obstructed the light. Electric lights under water were tried to overcome this difficulty, but were not very successful, and were abandoned by the divers when they had accustomed themselves to the layout of the work. When a 100-ft. length of the bottom 4 ft. layer had been put in, the forms were stripped, the trench filled in with stone to the level of the top of the concrete, and the forms reset for another layer.

As soon as the blockwork level was reached, the concrete was leveled off to receive the blocks and careful line and level given from the gantry, which was erected as soon as the trench behind the wall had been filled up. A light section steel rail was used by the diver to level off the concrete for the blocks. The temporary block-setting crane, to be described later, was then erected, and a length of the first row of blocks set and backed up with mass-concrete. One cubic yard wrought-iron skips, the bottom of which opened automatically, were used to deposit the concrete.

The same class of forms was used for the back of the wall under water as for the foundation work, but slightly modified to enable them to be attached to the crane gantry piles for support.

The blocks were laid with dry joints, Flemish bond, and bonded in addition with 12-in. diameter concrete-in-bag joggles. The top of the masswork backing was leveled off sufficiently wide to take the next course of blocks. The blocks were easily handled by the divers, the cranes working smoothly by means of an arranged code of signals.

DIVERS' WORK.—A force of 12 divers was kept going, the foreman diver and an assistant setting the blocks, and the others setting and stripping forming and erecting the gantry, the two mixers following up with the mass-concrete. The divers were housed in boats, with plenty of room in them for small stores.

Much expense was saved in the purchase of new diving suits by the employment of a skilled repairer. Many divers insist on throwing away, as unsafe, dresses which have become frayed and leaky. This soon happens to the exposed parts of the dress on work where blocks and timber have to be pushed around, and this renewal, on a work of any magnitude, adds considerably to the labor cost. Rubber and jute canvas patches can easily be put on the dresses with repairing solution. A good plan is to cover the more exposed parts of a new dress with protecting patches of this material, and renew them, before the dress itself is attacked. Detachable guards are sometimes used, but are troublesome to the wearer, as the addition of any unnecessary equipment outside of the ballast, piping and signal lines, hinders free movement, and, of course reduces the working efficiency of the diver and adds to the cost of the work.

In work which is difficult of access the fewer lines a diver has to look after the better. The more common accident happens through a diver getting his equipment mixed up and being unable to extricate himself. Each diver should have an intelligent attendant who can see ahead and get the material, tools, etc., on the spot at the right moment, and so avoid delays and the necessity of the diver's ascent to give verbal instructions. Much of the often abnormally high cost of diver construction is caused by the lack of system. A portable telephone is a very useful adjunct, but is a convenience more than a necessity to the work.

FORMS.—When the last exposed course of blocks was set, they were carefully alined, any error being adjusted. A complete 120-ft. length of forming for the work above block level was made in 20 × 4 ft. movable panels, double

*Portion of paper read before Canadian Society of Civil Engineers, April 29, 1909.

†Transcontinental Ry., Ottawa, Can.

braced in front, and made in panels to suit the counterforts in the wall behind, all held together by 1 in. diam. bolts and braced with removable struts of 4 x 2-in. stuff inside. Coach screws from the outside were used to secure the lagging to avoid bolt heads in the wall face of the forming. The forms for the first layer above block-level were placed in position on the ebb tide and at once concreted up.

The existence of the counterforts provided assistance in steadying the forms and preventing movement. The forms were then placed in position to quay level and foundation bolts, etc., set in position and concreted up.

It will be noted from the drawing that the forming for the back of the wall below the water line was attached to the crane gantry uprights. It was not possible to do this for the upper exposed work, as the gantry, although very steady for a temporary structure, vibrated sufficiently to have injured the alinement of the wall where it showed above the water line, although this movement was of no account lower down behind the wall.

The upper course of blocks, coming as it did well clear of the low water line, enabled the most difficult part of such work, namely, that around the low water line, to be done easily on the ebb, the two feet or so of a fall and rise of the water below the block line giving sufficient time to concrete up ahead of the incoming tide. Care was taken to make the forms as nearly water-tight as possible at this part to prevent the sea from sucking out the green concrete and pitting the face of the wall.

The lower layer of forms was weighted down with rails to prevent flotation, when the concrete was still new, and no trouble at all was experienced from movement of this part of the forming.

The concreting progressed continuously with but few delays, the lower panels being removed after three days, reset on a new length, and replaned where any slight warping of the face had taken place. A very good surface was thus obtained. Unfortunately for the use of wood lagging, the warping takes place shortly after the concrete is placed in position, and while it is yet green enough to take the impression of the swollen joints. A thin covering of steel plate on the face of the lagging, the joints of which should be left slightly open to provide for swelling of the timber, overcomes this trouble where a perfect concrete surface is a desideratum without resorting to plastering or acid treatment. All-steel forms are not sufficiently resilient for sea work; lacking resilience they have to be made unreasonably heavy and costly to resist the rough handling they have to undergo. The writer has seen massive forms used in breakwater construction, braced with steel T's, irreparably twisted out of recognition, whereas all timber forms, though perhaps badly damaged, could, at least, be repaired and re-used.

The exposed facing of this well, consisting of 1 part cement and 3 parts granite chippings, was deposited simultaneously with the backing to form a homogeneous mass, the facing during placing being kept separate from the poorer quality concrete behind by a 6 x 1-ft. steel plate, with handles on one edge, and held the necessary distance from the face of the wall by thin plates riveted on the face. One man moved this plate up as the work progressed, and deposited and carefully rammed the facing material, and the result, with careful form repairs, and the liberal use of the soft soap, was very satisfactory.

DESIGN OF SECTION.—The small ratio of width to total height is a feature in this well, particularly noticeable at the lower block line, and also the great height of the vertical back of the wall totaling 68 ft., differing from the usual conception of a non-reinforced quay wall in British practice, in that the usual series of offsets or steps are omitted.

This was made possible by the high angles of repose of the material forming the backing of the wall. This backing is of large rubble, with the interstices filled with smaller spalls, and would stand with but slight support to within a few degrees of vertical. Making allowance for quay loading and strain from moorings it is much lighter in section than usual, the design being doubtless influenced by the quality of the backing. The writer has seen walls of similar general design, notably at Liverpool, Bristol, and Leith, with twice the ratio of width of foundation to height that is used in this wall, but the backing employed was of softer dredged or other material, which flattens down to a comparatively small angle with the horizontal on exposure to water action.

No signs of weakness whatever have appeared in this wall. Possibly the introduction of a reinforced offset at the base of the back, and the use of a few old rails placed vertically near the back of the lower half of the wall at the point where the tensile stress is greatest would have increased the sense of security, though not necessarily the stability of the wall.

The Use of Cement in Sea Water.

Cements used in Britain, similar to that used in this work, have so far successfully withstood the action of salt water, with, of course, the inevitable exceptions sometimes due to bad workmanship, and in several of the earlier examples of concrete in sea water, to an insufficient knowledge of cement.

One precaution should always be taken in depositing concrete under water, namely, to raise the skips slowly and carefully for the first foot or two to allow the concrete to fall away easily and not be stirred up unnecessarily. Of course a small percentage of cement was unavoidably lost, but with careful manipulation of the depositing skips the amount was negligible. After each layer had set, and before another was deposited on top of it, the whole surface was brushed and cleaned. From two to three inches of slime, precipitated by the action of the cement on the sea water, always accumulated on the wall under water after concreting. Failure to remove this deposit on the concrete in sea water has been the fruitful source of wall failures. The cement particles in green concrete coming into contact with the sea water produce a chemical change in the cement and precipitates magnesia from the water.

This process takes place most easily before the concrete has set, and to a lesser degree after it has set. In sea water, concrete which has not set should, therefore, be protected until the cement has had time to crystalize and set, and the part of a wall where work has been left off under water and another layer has to be placed later, should be thoroughly scrubbed with wire brushes to remove any particles of the cement which have been damaged by contact with the sea water in an unset state. The particles in most hydraulic cements develop a certain amount of heat during the process of hydration, and tend to rise like an effervescence from the surface of the wall. It can be readily understood that the process of depositing and leveling concrete in the water aggravates the deposit of this precipitate. Possibly the fact that the geological formation of this particular district is of limestone and chalk, and consequent impregnation of the sea water may account for the unusually large amount of the precipitate in this particular case. The writer simply states the case as he personally observed it. The writer dried and tested this slime and found it to have absolutely no setting properties whatever, simply drying up into a fine powder when mixed into testing blocks, so that its introduction in the wall in layers would have prevented bond and made a horizontal joint of non-cementing material, probably ½-in. thick when compressed right through the wall at every 4-ft. layer, which would have caused lateral weakness in the wall. Although this is a gravity wall, and is calculated to have sufficient deadweight to resist lateral thrust, nevertheless the introduction of what would have been a series of joints on the tension face of a comparatively thin wall like this would not in view of mooring stresses have been a desirable feature, although dry joints in the blockwork face do not matter as they are under compression on that side of the wall.

The writer is of opinion that many cases of failure of concrete in the sea is due to a hot cement being used which swells during the process of hydration and setting in the work, producing holes and cracks which remain in the work after hydration is complete. These afterwards fill up with this same precipitate deposited by the salt water action on the cement, which, having no cementing value, rots away the wall, and the latter finally bursts off in large pieces. The writer has examined walls where pieces have broken away in this manner, and has detected the presence of a coating of this slimy material in the cracks. If the wall were perfectly solid the sea water could not find its way in and so cause this material to be deposited. The same occurrence in a milder form is to be seen in the efflorescence, which shows on ordinary concrete buildings in the form of white blotches and streaks of powdery material. A concrete which is not solid, and allows the water to freeze and expand in the cracks, is also undoubtedly the cause of failure of concrete in many cases, in water subject to frost and variations of water level.

The use of too much neat cement on the surface of a wall also tends to scale off the outer layer and produce hair cracks on account of the different exposure and ratio of expansion and contraction it bears to the inner concrete where more aggregate is used. To avoid this particular defect on the face of a wall, the aggregate should be worked out against the shuttering and the wall covered with damp sacking while the concrete is maturing.

One insuperable difficulty in mass-concrete in water with variations in level caused by the tide is the difference in the expansion and contraction of the concrete above water and that under the water. Blockwork is not so much affected by this since the joints allow free movement. The constantly alternating water levels and consequent changes in expansion and contraction of the material in the wall is very trying to good work, and soon shows its effect on poor concrete around the water line, and when this is coupled with any of the above-mentioned causes of decay, soon results in total failure.

A breakwater in Scotland, of which the writer has knowledge, built in the pioneer days of concrete in sea work, presents an appearance which clearly indicates a failure to appreciate the importance of thorough aeration of the cement and removal of the salt water-cement precipitate from the top of the layers as deposited, and has been the immediate cause of numerous and costly repairs. At that period, of course, concrete in sea water was in a more experimental stage, and many, though not all, of the difficulties then encountered, both in the chemical composition and constructional use of cement for sea work, have been overcome. This breakwater shows joints of soft material, presumably this same precipitate, at every place where concreting had been stopped, and innumerable small hair cracks and holes in the body of the wall, filled with the same material. It has also, in parts, a spongy appearance, even where it is not exposed to wave action, which indicates a tendency for the cementing material to gradually eat away. This is the case in these earlier works, and age only can prove whether modern works will outlast this trouble, which would seem to be a gradual decomposition induced chemically. Vibration in the concrete, caused by the continual pounding from waves, might cause fatigue and consequent failure of the cementing material in a wall exposed to wave action, and has done so, but could not be the cause with sheltered work.

At Portland the temperature is never sufficiently low to cause freezing sufficient to affect concrete exposed to tidal action in sea water, but the writer has seen cases where the alternate wetting and drying of sea walls, and consequent freezing of the concrete around the water line, has caused the concrete to scale and burst off in large pieces, presenting a very unsightly appearance. Breakwaters which are wetted by spray or waves above the water line also sometimes present this appearance when subjected to frost. Probably the introduction of some waterproofing material in the outer facing of a concrete wall would improve matters, but although several compositions are on the market, the writer is not aware of any case where waterproofing of concrete has been tried successfully in sea water, if at all necessary. Proper protection of the face of a quay wall from damage by shipping is very desirable, as it is a difficult and costly operation to repair it effectively.

After completion of the wall, and removal of the gantry, the space in front at the base of the wall was leveled up, and also the filling placed behind the wall. The stone used was deposited from 120-ton steel barges with opening bottoms. Above the water level, in the reclamation work behind the wall, the material was deposited from end tipping stone wagons, spread in layers and rammed. A double-track railroad of 80-lb. flat-bottomed rails on 9 ft. x 10-in. x 5-in. creosoted pitch pine ties, with crossovers and wagon turntables, was laid on the quay behind the main wall.

The contractors for the whole of the work were Messrs. W. Hill & Co., of Westminster, London, the writer being their chief assistant engineer, with outside charge of the work.

Present Tendencies in Technical Education.*

By FREDERICK E. TURNEAURE.†

So long as division of labor continues to develop, thus separating more and more the producer from the consumer, the engineer will be called upon in ever increasing numbers to develop and transmit the power, to manufacture and operate the machinery and to provide the transportation facilities on larger and larger scale. Through the development of agricultural machinery, a smaller and smaller percentage of the world's population will be required to procure the raw material for food and clothing, and a constantly increasing percentage will be employed in meeting our wants and necessities in the form of manufactured articles and in transporting them from producer to consumer. A larger and larger proportion will of necessity dwell in large groups involving a complex life, and even the life of the agriculturalist will be increasingly complex. All these conditions tend to increase the demand for men trained in the knowledge of materials and the laws of physics and chemistry. In law, medicine and theology, and even in pedagogy, there seems to be little reason why the demand should increase more rapidly than the population and, on some accounts, it is likely to be less rapid. With the engineer exactly the reverse is true.

DIFFERENT KINDS OF TECHNICAL TRAINING NEEDED.—Engineering is commonly and with truth called a "profession." For many technical men it is a profession, but for others and larger numbers, it can scarcely be said to be such. The technical requirements requisite for the performance of various duties vary between wide limits. Innumerable callings require a greater or less amount of technical training, some of which might fall within the class generally considered as engineering, while others would not. The profession of the engineer is, for these reasons, somewhat indefinite, and probably will always remain so, unless some formal method be adopted by the state to differentiate by examination, or to recognize examinations conducted by educational institutions. It does not seem important, from the standpoint of the engineering educator, that such differentiation be emphasized; but it is important that the requirements of society in the field of technical education be understood and provided for.

* A Short Extract from the Presidential Address to the Society for the Promotion of Engineering Education at New York City, June 24, 1909.

†Dean of the College of Engineering, University of Wisconsin, Madison, Wis.

On the one hand, no training can be too thorough, no culture too broad for the real professional engineer. On the other hand, it is unquestionably true that large numbers of young men who could not possibly afford such a long course, can be greatly helped by technical instruction extending over a period of two or three years. Up to the present time engineering instruction in this country has been confined almost entirely to the standard four-year course, and the curriculum has been arranged primarily with a view to giving the best possible instruction to students who expect to remain four years and no longer. The student who wishes to get some technical training to assist him in his chosen vocation, but who cannot stay four years, is not well provided for; the needs of such students have been recognized in but few places. I believe it may be said also, with truth, that the present courses are also not well adjusted for those who wish to secure a more thorough preparation for the profession. Post-graduate work in engineering can hardly be said to be a success. After completing a four-year engineering course few students find much profit in continuing longer at the school.

More specific provision for both these classes seems likely to receive more consideration in the near future.

FIVE AND SIX-YEAR COURSES.—Within the last two years much has been done towards the encouragement of longer study by a better development of the five and six-year courses.

It is believed by many that four years is long enough for a young man to spend in college, and that he can then profit more by getting into practical work than by remaining longer in school. This is doubtless true for a large proportion of students. But there still remains the fact that breadth of view and thoroughness of training must ultimately be secured by the successful professional man. Experience has shown that it is worth while for the lawyer and the physician to devote a very considerable time in school to liberal studies as well as to their professional courses. The engineer is in no less need of such training; indeed his relatively isolated position during the early years of his professional life would appear to indicate that his need is even greater than that of the lawyer. If this is true, should not the schools encourage such education by a convenient arrangement of courses, the granting of suitable degrees and, on the part of some schools favorably conditioned, by giving exclusive attention to courses of this character?

CONCERNING "FUNDAMENTALS."—It is often said and frequently reiterated that we should teach only fundamentals. We probably all agree to that statement, but might not agree on what are fundamentals. It might fairly be claimed that the fundamentals of engineering are covered by the pure sciences, mathematics, theoretical mechanics, and materials of construction. But we all go much beyond these studies in our courses and undoubtedly with profit to the student. The fundamentals of geometry may be considered as the axioms. Given the axioms, a well-trained man can (with difficulty) construct his own geometry. Bridge stresses is simply advanced statics, but this subject is taught in all civil engineering courses. The fact that such a subject can be more readily and effectively learned in school than in practice, and the further fact that a considerable group of students is quite likely to have early use for it in practice, makes it a fair proposition to teach it in school. We must, of course, confine ourselves to the fundamentals of any subject, which simply means, I take it, that we should not take the time of a student in teaching details of practice which he can better learn outside.

STUDY OF MATERIALS.—In technical lines, probably the direction in which advanced work can most profitably be extended is in those studies closely related to laboratory investigations, to theoretical analysis and to the study of properties of materials. In the last-named subject, especially, there is a great need of better knowledge. A new epoch in the study and utilization of materials seems to be upon us, and one of the most promising fields of development in applied science is along these lines. This will carry with it increased laboratory study in chemistry, electricity and metallurgy.

ENGINEERING RESEARCH WORK.—Closely related to the development of longer courses of study is the recent growth of research in applied science as related to engineering. Following somewhat the growth of the agricultural experiment station, research in the engineering sciences has been very greatly developed during the past four or five years. In at least two institutions a special organization, called an "engineering experiment station" has been established, whose function it is to carry on research in the engineering sciences, particularly in those directions which most concern the interests of the state in question. Such research has also been greatly promoted and developed in institutions having no special organization for that purpose, the work being carried on as a part of the regular duties of the several departments.

Fruitful research is also of much value in cultivating helpful relations between the teacher and the practical engineer. The latter is coming more and more to utilize the very latest results of experiments in his line, and to look more and more to the engineering investigator for practical assistance in this way.

SHORT COURSES.—The third phase of educational development has to do with courses and methods of instruction adapted to those who can complete only a relatively short curriculum. The four-year course does not adequately meet the great variety of needs of this class of students. The trade-school, as such, is not a school to which the American public seems to take kindly and its development has been very meager in the past. There are signs, however, that the regular trade school, as well as the secondary technical school, is likely to be given much more attention in the future.

SECONDARY TECHNICAL SCHOOLS.—Schools of a secondary grade are needed in every large manufacturing center. At the present time there are few opportunities for young men to secure any technical education whatever, except by completing a four-year high school course, and then by pursuing a regular four-year engineering course in an engineering school. There is no reason why a large and profitable amount of technical instruction cannot be given without so long a preparation. A thoroughly sound and practical course in mechanics can be taught without calculus, and two years' instruction of the right kind will be of great assistance to many workers in industrial life. Such opportunities should and will be offered more adequately than is the case at the present time.

Up to the present time the state has not, in general, extended its support to trade and secondary schools. There is no fundamental reason, however, why this should not be done. Already, in at least three states, legislation has been enacted leading in this direction, and trade schools and secondary schools are now being supported by taxation.

CORRESPONDENCE INSTRUCTION.—Correspondence instruction by the state has been established in at least one state and has there been placed upon a sound financial basis. The demand for such instruction has come about largely through the lack of secondary schools in the large industrial centers, although such correspondence instruction meets other demands as well. It is a notable development which meets a real demand, and which is certain to extend in some form or other.

It thus seems likely that there will develop many more schools in our industrial centers of somewhat lower requirements than the present standard engineering schools. To abolish the four-year course, and require all students to pursue a five or six-year course, would be unfair to a large number of students who cannot afford the long course. Such action might well be justified on the part of privately endorsed institutions, but on the part of state institutions the less well prepared student should not be barred from profiting by technical education. A two-year or three-year course offered side by side with the five or six-year course, would very likely meet his needs better than a four-year course.

Steam Shovel Records on the Culebra Cut of the Panama Canal.*

The highest steam shovel records in the Central Division up to the present time are:

HIGHEST MONTHLY RECORD, ENTIRE DIVISION.—2,065,827 cu. yds. in March, 1909, 27 working days; average per day, 76,512 cu. yds.

HIGHEST DAILY RECORD, ENTIRE DIVISION.—78,559 cu. yds., April 5, 1909, 57 shovels; average per shovel, 1,378 cu. yds.

HIGHEST MONTHLY RECORDS.—45-ton Bucyrus—25,713 cu. yds., July, 1908, shovel No. 59, 26 days; average per day, 989 cu. yds.

70-ton Bucyrus—53,043 cu. yds., March, 1909, shovel No. 122, 27 days; average per day, 1,965 cu. yds.

95-ton Bucyrus—58,483 cu. yds., October, 1908, shovel No. 230, 27 days; average per day, 2,166 cu. yds.

Model-60 Marion—41,219 cu. yds., March, 1908, shovel No. 152, 26 days; average per day, 1,585 cu. yds.

Model-91 Marion—55,419 cu. yds., August, 1908, shovel No. 256, 25 days; average per day, 2,217 cu. yds.

HIGHEST DAILY RECORDS.—45-ton Bucyrus—1,353 cu. yds., Feb. 5, 1908, shovel No. 58.

70-ton Bucyrus—2,300 cu. yds., Feb. 9, 1908, shovel No. 131.

95-ton Bucyrus—3,941 cu. yds., March 2, 1909, shovel No. 220.

Model-60 Marion—1,704 cu. yds., April 18, 1908, shovel No. 152.

Model-91 Marion—3,485 cu. yds., Jan. 21, 1909, shovel No. 265.

Monthly records are based on place measurement and daily records are based on car measurement.

These shovels are under steam for eight hours per day, but are not actually worked during this entire period, time being lost by the necessity of moving the shovel forward, blasting stone too big for the shovel to handle, keeping the shovel supplied with cars, etc.

*From the "Canal Record," June 9.

Extravagant Expenditure on Engineering Works.*

The judicious expenditure of funds forms one of the most important and difficult duties imposed upon an engineer responsible for the design and execution of engineering works. That the annual waste of money is enormous we cannot doubt. By waste is meant expenditure incurred in engineering construction, which, by a modification in design, in material used, and methods of execution, might and ought to have been saved, without in any way prejudicing the efficiency and fitness of the results.

The President of the Institution of Civil Engineers has lately, on more than one occasion, drawn attention to the subject we are discussing. In his presidential address to the Institution he referred to the desirability of public funds devoted to engineering work being administered by definitely qualified engineers.

Assuming the general principle of the design of any particular structure or works to be suitable in every way, cases do occur where nothing short of the best materials and workmanship obtainable, irrespective of cost, will satisfy all the requirements. Such conditions are, however, comparatively rare, and the engineer is usually called on to provide, not the best and strongest work obtainable, but something that is good enough for the purpose in view. There is considerable difference between the best and what is good enough, and engineers who insist upon expensive granite work instead of a cheaper construction—to give only one instance—when the latter is good enough for the purpose required, are not only extravagant, but guilty of waste.

Many of the big authorities and companies who employ thoroughly capable and often eminent engineers have spent, and do spend extravagantly. In some cases the office has no doubt grown up with extravagant ideas. The usual practice has been to do certain things in a certain way, and there has always been, comparatively speaking, plenty of money.

The chief draftsman, the head of the drawing-office, who has a great deal to do with the design and type of the drawings turned out, is frequently an indoor man, and has not had much experience in actual carrying out of work. A man holding such a position in a large office, one on whom considerable responsibility rests, should be an engineer with practical experience of works.

Furthermore, resident engineers now not infrequently seem to lack the authority, initiative and readiness to take responsibility which was accorded to them, or which they arrogated to themselves in the past. They are more often dependent on their superiors, and hesitate or are unable to act without instructions from the head office to an extent which used not to obtain. We do not think that this tends to promote efficiency or economy.

The calls on the time of chief engineers controlling great interests and a large staff are very great, and always increasing. With the exception of a few, possibly not more than one or two, chief assistants, other members of the staff in positions of considerable responsibility, and having control of the expenditure of very large sums of money, are in very subordinate positions and paid very low salaries. Many resident engineers in charge of works of importance, which the chief engineers can seldom visit, are paid ridiculously small salaries. A chief engineer's time is of necessity to a large extent occupied by administrative work, committees, and correspondence, which often prevents him from devoting as much time and attention to the purely engineering part of his work as is desirable, and as he may wish to do. The not infrequent consequence is that waste of money results, and drawings are made and sent out which might well have been modified, and the cost reduced. The resident engineer, too much hide-bound by the contract drawings, specification, and the imprimatur of the head office, has not the authority, or lacks the initiative to make alterations or to bring the matter up for further consideration with his chief, and thus too often chiefs and employers do not get the best service out of their assistants.

The same *laissez faire* attitude sometimes permeates the whole office. It is a commonly expressed opinion in many big offices that it is no use trying to save the company money. A keen man will be told by one who has been some time in the office that when he has been there a little longer he will know better than to try to save money or to trouble himself by endeavoring to do so. This is not a satisfactory or wholesome point of view, but is nevertheless a very general one on the part of subordinates.

We venture to suggest that in the engineer's office of big companies and public bodies a confidential assistant to the chief engineer might be very useful to the chief and to his employers. Such an assistant would be altogether apart from the chief assistant or heads of departments. His work would be engineering, as apart from administration and routine duties. A young and active man would more than save the cost of his office and salary.

*From an editorial in "The Engineer" (London), May 14.

Notes from Engineering Schools.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY.—The sanitary research laboratory and sewage experiment station of the Massachusetts Institute of Technology has recently erected a new purification plant near the pumping station of the Boston Main Drainage Works at Dorchester. The laboratory and headquarters are to be located in the Pierce Bldg. of the Institute, and the quarters at 786 Albany St. have been given up.

CORNELL UNIVERSITY.—With the appointment of Mr. H. H. Norris as Head Professor of Electrical Engineering, the organization of this department has undergone some change. Beginning next fall there will be three main divisions of the department, each in charge of a professor or assistant professor. These divisions are: (1) introductory junior courses, (2) advanced laboratory courses, (3) advanced theoretical courses.

Mr. L. L. Nunn, of Telluride, Colo., President of the Telluride Power Co., operating a chain of hydro-electric power plants and transmission lines in Colorado and Utah, is building a dormitory and clubhouse on the campus to house the 15 or 20 special students who are kept at Ithaca by him. This building will be much like a fraternity house in its arrangement, with living rooms on the first floor and sleeping rooms in two floors above.

A LANDSLIDE CAUSED A FLOOD at Roosevelt, Idaho, June 3. The slide is reported to have been three miles long and 200 ft. in width. It choked the bed of Mule Creek, causing the water to rise to a depth of 100 ft. and floating many of the buildings in the town of Roosevelt.

A PREMATURE EXPLOSION OF DYNAMITE last week killed eight men who were engaged in breaking up the wreck of the Hill liner "Dakota" at the entrance of Tokio Bay. The wreckers had been employed by the Yamashina Marine Iron Works Co., which had bought the wrecked vessel from the insurance company.

The accidental discharge of a blast in the Oneida tunnel being driven by the Lehigh Valley Coal Co., near Freeland, Pa., June 27, resulted in the death of two workmen. The men had attempted to explode the charge and, upon failing, had returned to investigate when the explosion took place. Reports state that a third workman, who has since disappeared, is believed to have tried the electrical igniter just as the two killed reached the face.

A COAL MINE EXPLOSION at Wehrum, Pa., June 23, killed 17 men and seriously injured 16 others, one of whom died June 26 at Spangler Hospital. The mine itself was but little damaged. The explosion occurred in mine No. 4 of the Lackawanna Coal & Coke Co., between seven and eight o'clock Wednesday morning. The mine is worked only on Tuesdays and Fridays, but about 100 miners had entered, at the time of the accident, to get their daily allowance of coal for private use. On account of the accumulation of suffocating gases following the explosion, effective rescue work was not possible until about an hour afterward when oxygen helmets were obtained and the mine was thoroughly searched. The mine has always been so free from gas that open lamps have been permitted in all parts of the workings. It had been inspected by a State mine inspector about three weeks before the accident and pronounced free from gas. A thorough investigation has so far failed to uncover any definite explanation of the explosion.

A NUMBER OF RAILWAY ACCIDENTS have been reported during the past week. Passenger train No. 3 on the New York, Ontario & Western Ry. was partially derailed June 25 at White House Curve, three miles north of Livingston Manor, N. Y. The engineer and fireman were killed. The locomotive and combination baggage car left the track and went down the 10-ft. embankment. The first two coaches were derailed but remained on the roadbed. Many of the 100 passengers were thrown from their seats but none were seriously injured.

A rear-end collision of two trolley cars on the Claymont branch of the Wilmington (Del.) City Ry. June 24 severely injured 40 persons, of whom six are not expected to recover. The collision took place shortly before midnight at a curve on the outskirts of Wilmington. The two cars crowded with excursionists were close together. As the first car rounded the curve, its trolley pole left the wire so that its lights went out. The motorman of the second car, according to his statement at the hospital, had never been over that part of the line before and, losing sight of the forward car's lights, believed it had gone on around the curve. He proceeded at high speed and saw the first car, which carried no tail light, only when too close upon it to prevent the collision. His car was equipped only with a hand brake.

A confusion of meeting orders caused a head-on collision of two passenger trains on the Southern Ry. June 21 at Belmont, Ill. One man was killed and 22 others were injured. The trains were originally ordered to meet at Belmont and the meeting place was later changed to Browns, but the crew of the eastbound train failed to receive the second order. The westbound train was just starting from the Belmont station when the collision took place.

A broken wheel flange caused the wreck of an express train June 27 on the Erie R. R. near Binghamton, N. Y. Two men were killed. The defective wheel was discovered on one of the cars of an eastbound freight. When the freight was stopped on a curve to examine the wheel, the car left the rails and was shoved out across the westbound track. Before flagmen could be stationed, the westbound express came around the curve and was wrecked by the derailed car.

A large iron sewer-pipe rolled from a flat car in a Cleveland, Cincinnati, Chicago & St. Louis freight train in Indianapolis, Ind., June 25, and fell in front of the caboose, which was derailed and overturned. Three men in the caboose were injured.

THE PROPORTION OF GROSS EARNINGS PAID OUT in wages by a railway company during seasons of prosperity and of business depression is indicated by figures recently issued by the Pennsylvania Railroad Co.:

	Gross earnings.	Wages.	Number of employees.
1907	$321,478,308	$155,015,898	199,000
1908	267,559,213	125,543,947	175,000

The company paid out for labor in 1907 48% of its gross earnings and 46% in 1908. It should be noted that although there was a reduction in hours of labor of certain classes of employees the rate of wages paid in 1907 was maintained during 1908.

A 300-TON TESTING-MACHINE has been built for the Civil Engineering Department of Birmingham (England) University by W. & T. Avery, Ltd., of Birmingham. The machine is horizontal, has a hydraulic press for a straining mechanism, and weighs the load at the other end by a lever scale mechanism. It will take tension test-pieces up to 33⅓ ft. long, and compression pieces up to 30 ft. long. Bending tests can be made with central loading between abutments set to any span up to 20 ft. The hydraulic press employs a maximum pressure of 1,000 lbs. per sq. in. [after an article in "The Iron and Coal Trades Review," June 11, 1909].

THE 506-FT. GREAT FALLS CHIMNEY was put into service on June 12, the smelter plant being shut down for about 6 hrs. to permit making connections between the old and new smoke-flues. The change was made with little delay, and at present the whole plant except the reverberatory furnaces discharges into the large stack. The chimney itself was fully described in our issue of Nov. 26, 1908. The large dust-chamber which forms part of the flue is filled with wires hung vertically from the roof a few inches apart, to abstract all dust from the smoke; great results are expected from this device. Shaking arrangements for knocking the dust off the wires are provided, and the whole floor of the chamber consists of hoppers through which the dust may be dropped into cars in a cleaning pit below.

WORK ON THE CAPE COD CANAL was started on June 22, when August Belmont moved the first spadeful of earth. The canal as projected will be cut from Sandwich, in Barnstable Bay, to Buzzard's Bay, Mass. It will not only shorten the distance by boat between New York City and Boston by nearly a hundred miles, but it will also avoid the dangerous shoals and storms which are claimed to have caused nearly 2,000 shipwrecks since 1800. According to current newspaper items the canal will be eight miles long, 30 ft. deep and have a minimum bottom width of 100 ft. In addition to the cutting of the canal, four miles of channel must be dredged at each end to connect the canal with deep water, and breakwaters must be provided. Many earlier projects for a Cape Cod canal have been noted in these columns.

ANOTHER RECORD-BREAKING FREIGHT TRAIN is reported, this time from the Pennsylvania R. R. On June 14 a train 3,000 ft. long, consisting of 85 gondola cars loaded with 4,451 tons of coal, was hauled from Altoona to Enola, Pa., as a trial of what could be accomplished on the newly-revised Middle Division, where the maximum grade is now but 0.2%. The last step in making the revised line ready for traffic was the opening to service recently of an 11-mile section between Mt. Union and Ryde. The heavy train noted made the 124 miles in 7¼ hrs., at an average speed of about 17 mi. per hr. It was hauled by freight locomotive 1113, an engine of recent design. The total weight of the train was 6,151 tons. The Virginian Ry. train noted on p. 672 of our issue of June 17 weighed 6,023 tons behind the tender and carried a net lading of 4,310 tons, both these figures being beaten over 100 tons by the Pennsylvania train. It is also stated that while the latter was only a trial train, numerous regular freight trains having total weights between 4,500 and 5,300 tons have been hauled over the revised line in the past few weeks.

A LUMBER CUT of 165,000,000 ft., mostly white pine, was made in the winter of 1908-09 on the Bad River Indian Reservation in Wisconsin under the supervision of the U. S. Forest Service. This heavy cut for one season was due to the disastrous fires of the summer of 1908, which made it necessary to cut large quantities of timber at once to save it. The work was done under contract by the J. S. Stearns Lumber Co., which had been conducting lumbering operations before, it appears, but only at the rate of 65,000,000 ft. a year. A notable feature of the contract was the provision that all tops and slash should be burned. Brush burning was begun the latter part of April and has recently been completed. A force of from 500 to 900 men was required for this work alone. Strips at least 300 ft. wide, adjoining green unburned timber, had already been cleared of inflammable brush by burning it.

WHOLESALE PRICES of the principal staple commodities sold in the United States for the period from 1890 to 1908, inclusive, have been investigated by the U. S. Bureau of Labor. The investigation shows that wholesale prices of 258 commodities receded in 1908 from the high level of 1907, which was the year of highest prices of the 19-year period covered. The average for the year 1908 was 5.2% below that for 1907; 0.2% higher than that for 1906; 36.9% higher than for 1897, the year of lowest prices during the 19-year period; and 22.8% higher than the average for the ten years from 1890 to 1899.

In the financial depression of 1908 the prices of fuel and lighting, metals and implements, lumber and building materials, cloths and clothing fell, while those of food commodities rose.

A DUPLEX ARTICULATED LOCOMOTIVE, having one steam truck under the boiler and the other under the rear end of the engine and the front end of the tender, was noted recently in our columns. An engine of somewhat similar arrangement, but with the water tank and coal bunker on the same frames as the engine, has been built for the Nitrate Ry., of Chile (4 ft. 8½ ins. gage) by the Yorkshire Engine Co., of Sheffield, England. The engine is to handle train loads of 200 tons at 8 miles an hour on a 20-mile stretch of line between Iquique and Carpas, where there are grades of 3 to 4% (average grade 2.8%), and curves of 300-ft. radius.

The engine is of the 0-6-6-0 type, 48 ft. long over all, with a total wheelbase of 35 ft. 8 ins. and a rigid wheelbase of only 8 ft. 6 ins. (for each truck). One truck is under the boiler and the other under the rear tank. Each truck has six 45-in. wheels, and has at its rear end two outside high-pressure cylinders 17 × 22 ins., driving the front pair of wheels. A chimney for the exhaust of the rear truck is at the back of the tank. The Walschaert valve gear is used. The boiler is 5 ft. diameter, with 262 tubes 15 ft. long, and carries 118 lbs. pressure. The firebox is of the Belpaire type, 8¼ × 5 ft. inside, with a grate area of 40 sq. ft. The total heating surface is 2,306 sq. ft., of which 2,135 sq. ft. is in the tubes. Water is carried in tanks beside the boiler and in a large rear tank under the coal bunker, the capacity being 4,000 gals. of water (2,000 gals. in the rear tank) and 4 tons of coal. The width over side tanks is 10 ft., and the height to top of smokestack is 13 ft. 6 ins.

THE ROCK-DRILL SHARPENING PLANT of the Calumet & Hecla Mining Co. sharpens 3,640 drills per day. The drills to be sharpened are assorted according to length, and in passing them through the machine, a record is kept of the number and sizes of drills received from each shaft of the mine.

The drills as they come from the mines are placed bit end forward on a belt conveyor that takes them to the further end of the building in which is the sharpening plant. Here they are removed from the belt by hand and placed upon a chain conveyor which moves them through the heating forge. The chain conveyor is so timed that the drills are subjected to the heat for about three minutes. The temperature of the forge, which burns crude oil under pressure, is about 2,000° F. After passing the forge, the drills fall upon a moving apron which passes them on to the sharpening machine.

The pneumatic sharpener is driven by air at a pressure of 65 lbs. per sq. in. and strikes 1,600 blows per min. with a 5-lb. hammer and 4-in. stroke. It is controlled by a single foot lever and a hand lever operating respectively the clamp which catches the drills as they drop from the forge and the sliding carriage on which the hammer mechanism is mounted. After being sharpened, the drills fall from the jaws of the sharpener upon a second chain conveyor which takes them to the

upsetter, where a pneumatic hammer striking 100 blows per min. with 5-in. stroke acts directly upon the face of the drill to back the cutting edges to a plane at right angles to the drill axis and to restore at the same time the diameter, which had been somewhat reduced in the sharpening machine.

The drills next pass to the fluter where an 800-lb. steam drop-hammer provided with suitable dies straightens the vanes of the drill and reduces them to standard thicknesses. Two blows of the hammer are required for each drill. From the fluter, another chain conveyor takes the drills to the sizing machine, which consists of a die press, and reduces the drills to proper diameter, the diameter of the finished drill being proportional to its length.

In their passage from the sizer to the tempering forge, the drills are subjected to an air jet which cools them to a temperature below 600° F. The tempering forge is a duplicate of the heating forge except that it is narrower and a drill passes through it in about two minutes. Upon leaving the forge, the drills fall into a tank of cold water which leaves them ready for use. Since leaving the belt conveyor, the drills have been passing, in the process of sharpening, toward the entrance end of the shop. A chain conveyor lifts them from the tank to the under side of the conveyor belt which carries them over the remainder of the return trip to the point of entrance.

The installation comprises two complete sets of the machines mentioned and is now operating with a combined capacity of six drills per minute. It is stated that twice this number of drills can be handled if necessary. The shafting and conveyors are driven by a 50-HP., 2,300-volt induction motor and the compressed air used is taken from the large central compressing plant of the mine. An illustrated description of this installation was published in the "Engineering and Mining Journal," May 29, 1909.

TIMBER CROSS-TIES purchased by the steam and electric railways of the United States during 1908 numbered somewhat more than 112,000,000, costing, at the point of purchase, over $56,000,000, according to statistics just made public by the U. S. Bureau of the Census in cooperation with the U. S. Forest Service. Of this total number the steam roads bought 94% and the electric roads 6%. In 1907 the purchase of ties exceeded that in 1908 by some 40,000,000 ties, the reduction in the latter year being due, without doubt, to the business depression which caused the railways to limit their tie purchases to the lowest possible amount. The report further says:

It is very interesting to note the wide range of woods used for cross-ties. The preliminary report by the Census Bureau lists separately 15 classes or species. Of these the oaks are now and have always been by far the most important. The oak ties amounted to more than 48,000,000, or 43% of the total quantity purchased. Next to these ranked the southern yellow pines, with 21,500,000, or 19% of the total. It will be seen that the oaks and southern pines combined furnished nearly three-fourths of all the ties bought by the railway companies last year. Cedar and chestnut supplied more than 8,000,000 ties each, and Douglas fir nearly as much. About 4,000,000 tamarack ties were purchased, nearly 3,500,000 cypress ties, and, in round numbers, 3,000,000 each of Western pine and hemlock. Redwood, white pine, lodgepole pine, gum, beech, spruce, and several other woods were used in smaller quantities.

While the oaks, and particularly the white oaks, have always been the preferred woods for cross-ties and still form a large proportion of the total, the increasing prices which the roads have had to pay for satisfactory oak ties are forcing them to look more and more for substitutes. This accounts in part for the great variety of woods reported. White oak, untreated, makes a tie which gives excellent service for many years, but it has been found possible to take woods which naturally are not durable, give them a treatment with either creosote or zinc chloride, which will prevent decay, and thus get much longer service from them than can be secured from untreated oak ties. Among the woods which have been most largely treated so far are the yellow pines, particularly loblolly pine, Douglas fir, western pine, and lodge-pole pine.

This year's statistics adds to the list two kinds of cross-ties which previously had not been reported in sufficient quantity to justify listing them separately. These are gum and beech. The purchases of gum ties in 1908 exceeded 200,000, while but slightly more than 15,000 of them were reported in the previous year. Of beech ties, the purchases in 1908 amounted to nearly 193,000, against but little more than 51,000 in 1907. These are woods which are distinctly not suitable for cross-ties unless they are given preservative treatment. Their increased use, therefore, is one of the many results of the progress of good preservation in the United States. For many years beech has been one of the principal cross-tie woods in Europe, where its value when given chemical treatment was long ago recognized. It is not uncommon for European roads to secure from 20 to 30 years' service from beech cross-ties. Untreated they would not last long enough to warrant their use at all.

Personals.

Mr. U. S. Marshal, of Sacramento, Cal., has been appointed City Engineer of Roseville, Cal.

Mr. Geo. W. Ristine, President of the Tennessee Central R. R., has resigned, effective July 1.

Mr. William Kent, M. Am. Soc. M. E., has resigned his position as General Manager of the Sandusky Foundry & Machine Co., at Sandusky, Ohio.

Mr. R. L. Baker, formerly Instructor in Experimental Engineering at the University of Wisconsin, has entered the service of Mr. A. Bement, Consulting Engineer, of Chicago, Ill.

Mr. L. Stubbs, Resident Engineer of the Houston & Texas Central R. R. at Ennis, Tex., has resigned that position to become Supervising Engineer of the Galveston causeway.

Mr. Alfred E. Kornfeld, Business Manager of the Engineering News Publishing Co., will sail for Europe on the "Mauretania" on July 14. He expects to remain abroad until September.

Dr. Walter Bensel, the Sanitary Superintendent of New York City, has been nominated by President Taft to be First Lieutenant in the Medical Reserve Corps of the U. S. Army.

Mr. A. G. Christie, Research Assistant in Engineering at the University of Wisconsin, has been made Assistant Professor of Steam Engineering, in charge of experimental mechanical engineering.

Mr. John B. Dickson has been appointed Superintendent of the Rochester division of the Erie R. R. to succeed W. J. Sharp, deceased. Mr. Dickson was formerly Assistant to the General Manager.

Mr. Stephen U. Hopkins, until recently Assistant Engineer for the New York Public Service Commission, First District, has become Consulting Engineer of the United Engineering & Construction Co., 620 Lumbermen's Bldg., Portland, Ore.

Mr. G. B. Strickler, M. Am. Soc. C. E., lately Resident Engineer on the Pacific Division of the Panama Canal, is in Havana, Cuba, as Resident Engineer of the Almendares River Bridge, which is being constructed under Wm. Barclay Parsons as Consulting Engineer.

Capt. John H. Poole, Corps of Engineers, has been relieved from duty as Superintendent of the State, War and Navy Department Building at Washington, D. C., and has been ordered to enter the next class at the Army School of the Line at Fort Leavenworth, Kan. He will be succeeded at Washington by First Lieut. U. S. Grant, 3d, Corps of Engineers.

Mr. D. K. Van Ingen, Assistant District Engineer of the New York Central & Hudson River R. R. at Syracuse, N. Y., has been transferred with the same title to Corning, N. Y., in charge of territory covered by the Pennsylvania division. Mr. H. L. Preston, Assistant Engineer at Syracuse, becomes Assistant District Engineer to succeed Mr. Van Ingen.

Henry Floy, M. Am. Inst. E. E., of New York City, has been retained by Mr. Bion J. Arnold, M. Am. Inst. E. E., in connection with the appraisal of the properties of the Metropolitan Street Ry., the Third Avenue Street Ry., and the Brooklyn Rapid Transit Co., New York City, which Mr. Arnold is making for the Public Service Commission of the First District.

Mr. Austin Cary, Assistant Professor of Forestry at Harvard University, has been appointed Superintendent of State Forests of New York to succeed William F. Fox, whose death was noted in our issue of June 24. Mr. Cary has been engaged in forestry since 1893. He has been associated with the forestry department of Maine and with the U. S. Forest Service, and was at one time an instructor in forestry at Yale. He has been at Harvard for about four years.

Hezekiah Bissell, M. Am. Soc. C. E., has resigned his position as Chief Engineer of the Boston & Maine R. R., but will be retained in its service with the title of Consulting Engineer. Mr. Bissell was graduated at the Sheffield Scientific School of Yale University with the class of 1861, and three years later he became an assistant engineer of the Union Pacific Ry., staying with that company until 1869, at which time he had become a resident engineer of construction. For the three years following, he was employed on what is now the Adirondack branch of the Delaware & Hudson Ry. In 1872 he went to Peru to take part in the construction of the Puno & Cuzo Ry. and remained there until 1874 when he was engaged to make an examination of bridges in Illinois and Indiana. He became Master of Maintenance of Way of the Eastern R. R. in February, 1878, and upon the consolidation of that road with the Boston & Maine, he was made Chief Engineer of the entire system.

Mr. B. W. Guppy, M. Am. Soc. C. E., Bridge Engineer of the Maine Central R. R., will succeed Mr. Snow as Bridge Engineer of the Boston & Maine R. R.

Mr. J. Parker Snow, M. Am. Soc. C. E., Bridge Engineer of the Boston & Maine R. R., has been chosen to succeed Mr. Bissell as Chief Engineer and will assume the duties of that office July 1. Mr. Snow is a graduate of the Thayer School of Civil Engineering, class of 1875. He has been Bridge Engineer of the Boston & Maine since 1888.

Obituary.

Patrick H. Dolan, Superintendent of the Pittsfield Electric Street Ry., died June 25 at his home in Pittsfield, Mass., aged 51 years.

W. F. Elrod, Assistant Superintendent of the Toledo & Ohio Central Ry., died June 25 at Bucyrus, Ohio, during an operation for cancer of the throat.

William Nugent, a civil engineer employed by the Delaware, Lackawanna & Western R. R., was drowned June 27 in Estling Pond at Denvil, N. J. Mr. Nugent is said to have taken part in laying out Estling Pond for the D., L. & W. R. R. 13 years ago.

George S. Gatchell, M. Am. Soc. C. E., Manager of the Buffalo Elevating Co., Buffalo, N. Y., died recently at Canandaigua, N. Y., aged 62 years. He was for several years Chief Engineer and later General Superintendent of the Buffalo, New York & Philadelphia Ry., now a part of the Pennsylvania system.

T. G. Baylor, Resident Engineer of the Chesapeake & Ohio Ry. on the Barboursville cut-off west of Charleston, W. Va., died June 20 at his home in Charlestown, W. Va., aged 61 years. Mr. Baylor was a graduate of the Virginia Military Institute in the class of 1871. He had been in the service of the Chesapeake & Ohio Ry. for the past seven or eight years and at the time of his death was just bringing to completion the first division of the Barboursville cut-off.

Engineering Societies.

COMING MEETINGS.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS.
July 5-9. Annual meeting at Seattle, Wash. Secy., A. H. Dimock, City Hall, Seattle, Wash.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
July 6-9. Annual convention at Bretton Woods, N. H. Secy., Chas. W. Hunt, 220 West 57th St., New York City.

OHIO ELECTRIC LIGHT ASSOCIATION.
July 13-15. Annual convention at Toledo, Ohio. Secy., D. L. Gaskill, Greenville, Ohio.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
July 15-16. Summer meeting at Indianapolis, Ind. Secy., W. M. Mackay, P. O. Box 1818, New York City.

NATIONAL IRRIGATION CONGRESS.
Aug. 9-14. Annual meeting at Spokane, Wash. Secy., B. A. Fowler, Phoenix, Ariz.

LEAGUE OF AMERICAN MUNICIPALITIES.
Aug. 25-27. Annual convention at Montreal, Can. Secy., John MacVicar, Des Moines, Iowa.

TRAVELING ENGINEERS' ASSOCIATION.
Sept. 7-10. Annual convention at Denver, Colo. Secy., W. O. Thompson, N. Y. C. Car Shops, East Buffalo, N. Y.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 8-10. Annual convention at New York City. Secy., Willard Kent, 715 Tremont Temple, Boston, Mass.

LEAGUE OF AMERICAN MUNICIPALITIES.—Among the subjects to be discussed at the 13th annual convention in Montreal, Can., Aug. 25-27, are the following: Municipal Charter Making (discussion led by Clinton R. Woodruff, of Philadelphia, Pa.; James G. Riddick, of Norfolk, Va., and S. J. Hay, of Dallas, Tex.), and Regulation and Control of Local Public Service Corporations by State Boards (discussion led by Louis Bets, of St. Paul, Minn., and Charles D. Huston, of Cedar Rapids, Iowa).

MICHIGAN GAS ASSOCIATION.—The 18th annual meeting will be held on a chartered steamship of the D. & C. line, leaving Detroit, Mich., Sept. 14. From Detroit, the boat will proceed to Sault Ste. Marie by way of Lake Huron, returning by way of St. Mary's River to Mackinac Island, where a stop of six hours will be made. It is planned to reach Detroit at about noon of Sept. 16. Sessions for the discussion of papers will be held on the boat—one each day of the trip—at which will be presented the following papers: "How We Sold Our Surplus Coke," Glen R. Chamberlain, Grand Rapids Gas Light Co.; "Studies in Coal Distillation," A. H. White, John H. Lyman and Wm. A. Dunkley, University of Michigan; "Retort Benches," A. S. B. Little, St. Louis, Mo.; Report of Cooperative Illuminating Gas Tests, as submitted by Perry Barker, formerly Assistant Engineer, U. S. Geological Survey.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS.—The seventh annual convention at Seattle, Wash., July 8-10, will be held in the Good Roads Bldg. on the grounds of the Alaska-Yukon-Pacific Exposition. The first day, July 8, will be taken up with an excursion of the members and guests. Sessions for the reading of papers will be held on Friday and Saturday mornings, July 9 and 10, and the afternoons and evenings will be left open to give opportunity for visiting the exposition. The papers to be presented are as follows: July 9, "The Mineral Industry of the Pacific Northwest," presidential address by Milnor Roberts, Dean of the School of Mines of the University of Washington; "Submarine Torpedo-Boats," by Frank W. Hibbs, Past-President, Pacific Northwest Society of Engineers. July 10, "Flow of Water Through Wood Pipes," by Theron A. Noble, North Yakima, Wash.; "Seattle Regrades," by R. H. Thompson and J. C. Jeffery, Past-Presidents, Pacific Northwest Society of Engineers.